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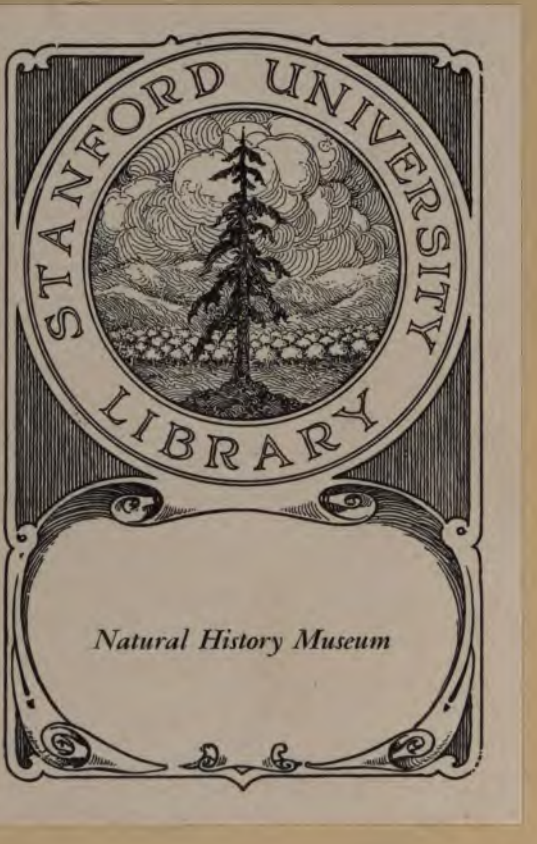
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VOLUME VII

THE PATICAE AND ANTHOCEROTES OF CALIFORNIA

BY

MARSHALL AVERY HOWE

NEW YORK
1899

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MARSHALL AVERY HOWE

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INTRODUCTION.

The aim of the subjoined work is to present a descriptive list of the Hepaticae and Anthocerotes of California, together with delineations of such species as have been hitherto either not at all or only quite imperfectly figured. Most of the material upon which the paper has been based was collected by the author during a residence of about five years in California. Of the Anthocerotes and the thalloid Hepaticae, specimens obtained in various stages of development were fixed with chromic acid and preserved in alcohol in order to retain better the natural outlines and also to permit a more accurate study of the internal structure through the use of microtome sections. Additional material has been contributed from time to time by friends and associates, among whom thanks are due especially to Miss Edith S. Byxbee, Dr. Willis L. Jepson, Professor L. M. Underwood, Professor Douglas H. Campbell, Professor A. J. McClatchie, Mr. S. B. Parish, Professor Edward L. Greene, Mr. M. S. Baker, Mr. F. P. Nutting, Mr. J. Burtt Davy, Mr. W. C. Blasdale, and Professor William A. Setchell. Specimens secured by the earlier collectors, notably the very important collections of Dr. Henry N. Bolander, have likewise been of great service. Through the kindness of the owners or custodians of various herbaria in Europe and America we have enjoyed the privilege of seeing, with two or three exceptions, the original materials of all the distinctively West American species which have been recorded as occurring within our limits.

It is possible that the first botanist to collect any Hepaticae in California was Archibald Menzies, who visited the region during the

last decade of the eighteenth century, though we are not in a position to affirm with certainty that he actually gathered any of these plants within the limits of what is now California, inasmuch as the only hepatic that we have seen, definitely known to be of Menzies' collecting (the original of *Porella navicularis*), is referred simply to the West Coast of North America, and the species is one that he may have found equally well, or better, farther to the northward. Dr. Thomas Coulter, about four decades later, seems to have been the discoverer of *Asterella violacea*, though it was a plant of Bolander's which, after the lapse of another forty years, served as the basis of Mr. Austin's diagnosis. Occasional Hepaticae were collected within the state from 1850 to 1880 by Dr. Albert Kellogg, Dr. J. M. Bigelow, Professor William H. Brewer, Professor John Torrey, Dr. C. C. Parry, and Dr. Edward Palmer. It was, however, Dr. Henry N. Bolander, who did much more than all the others to pave the way to a knowledge of the Californian hepatics. Dr. Bolander's services to Californian botany are too well known to need discussion here.* Suffice it to say that he was a resident of California from 1861 to 1878, and that while giving no more attention to cryptogamous plants than to the spermatophytes, his eye for mosses, liverworts, and lichens was astonishingly keen. He not only explored with much thoroughness the San Francisco Bay region, but as botanist of the State Geological Survey, and later as State Superintendent of Schools, was enabled to visit more remote portions of the state. Fully one half the species in the California hepatic list of today were known to him. Of these, at least twelve were new to hepaticology; seven now bear his name. The Hepaticae of Bolander's collecting were studied by Mr. Austin and by Dr. Gottsche. Professor W. G. Farlow visited the Pacific Coast in 1885 and collected a few plants of this group at various points in California. Professor L. M. Underwood also visited California in the summer of 1888 and made collections in Alameda, San Francisco, Marin, and Santa Cruz counties. Twelve specimens of Hepaticae were secured by Messrs. Coville and Funston on the Death Valley Expedition in the summer of 1891. In the summer of 1894, Mr. M. S. Baker and Mr. F. P. Nutting made a botanical journey through

* An interesting paper on "Dr. Henry N. Bolander, Botanical Explorer," by Dr. Willis L. Jepson, has appeared in Erythea, 6: 100-107. 1898.

portions of Shasta, Lassen, and Modoc counties, including in their collections several liverworts. Mr. Samuel B. Parish has found several species of Hepaticae and Anthocerotes in the San Bernardino Mts., and Professor A. J. McClatchie lists seventeen species in the "Flora of Pasadena and Vicinity."* Professor D. H. Campbell has made interesting discoveries in the neighborhood of Stanford University, two of which are the novelties *Sphaerocarpus cristatus* and *Riccia Campbelliana*, first described in the present paper. Mrs. Katharine Brandegee is thus far the only collector of Professor Campbell's new genus *Geothallus* and, so far as we know, is the only one to have found *Reboulia hemisphaerica* in California. Our own collections have been made in the region of the Bay of San Francisco, and in Sonoma, Mendocino, Humboldt, Trinity, Shasta, and Siskiyou counties. Although the hepatic flora of the coast counties may now be considered to be fairly well known, it is perhaps not too much to expect that explorations of the future will nearly double the number of species now known to occur in the state as a whole. That the present number—86, including one well-marked variety—is a very respectable one for the area involved may be readily seen by a comparison with the hepatic flora of the northern and eastern United States. In the sixth edition of Gray's Manual of the Botany of the Northern United States, 141 species are recognized by Professor Underwood under the Hepaticae. Subsequent additions and revisions leave the total about 150. When it is borne in mind that the area covered by the sixth edition of Gray's Manual is five times that of California, the 86 species now attributed to California make a fair showing in point of numbers as against the 150 of the northern and eastern states. But California has mountains of more than twice the height of any in the Gray's Manual region and in spite of the fact that the annual rainfall in many parts of the state is less than is requisite for the best development of bryophytic vegetation, the diversities of altitude, temperature, and humidity, afforded by the state as a whole, combine to give it a rich and varied hepatic flora, and one which in respect to the numbers of its species may be expected to compare favorably with any region of equal area in the United States. The whole great range of the Sierra Nevada is still almost a *terra*

* Reid, History of Pasadena, 624. 1895.

incognita so far as its bryology is concerned. The mountains of this range in order to yield the best results should be explored during the spring months, while the snows are leaving and while the ground is still moist. During the dry season, the terrestrial Hepaticae become shriveled and more or less covered with dust, and are usually difficult to detect. Several species known to occur in British Columbia, Washington, and Oregon are likely to be found also in northern California, especially, perhaps, near the well-watered coast. The more arid portions of the state will doubtless still yield Riccias and quite possibly new hepatic forms with special provisions for withstanding a season of drought, such as are exhibited by *Geothallus tuberosus* and *Anthoceros phymatodes*. Additions to the state list are to be expected from any quarter, but more particularly, we think, from the regions indicated.

On the following pages is a table designed to give some idea of the geographical range of the Hepaticae and Anthocerotes of California, taking into consideration only the hepaticologically better known portions of the Northern Hemisphere, the facts of distribution being compiled from the most recent and trustworthy sources. It will be seen that of our 86 species (representing 36 genera), 37 (43+%) occur also in the Gray's Manual Region (*i. e.*, the northern, eastern, and central United States, extending beyond the Mississippi River to the 100th meridian and southward to North Carolina and Tennessee); 40 (46½+%) in the British Isles; 46 (53½—%) in northern and central Europe; 46 (53½—%) in the Mediterranean Region of Europe; and 36 (42—%) in northern Asia (including Siberia, China, and Japan); 37 (43+%) are peculiar to Pacific Slope of America, several of them having not yet been found outside of California. It is of some interest to remark that the number of species peculiar to the Pacific Slope is proportionally greater than of those peculiar to the Gray's Manual Region, even though we may not stop to prove this by figures. The difference between 43% and 53½% is sufficient to justify the assertion that the hepatic flora of California has more in common with Europe than with the eastern and central United States. But facts involving the consideration of species do not always lend themselves with grace and accuracy to mathematical modes of expression. The European species *Porella laevigata*, *Riccia ciliata*, and *Anthoceros*

California.	Eastern U. S. (Gray's Manual Region).	British Isles.	Northern and Central Europe.	Mediterranean Region.	Northern Asia (Siberia, China and Japan).
1. *Riccia Lescuriana**.	*	*	*	?	
2. *trichocarpa*					
3. *Californica*					
4. *glauca*		*	*	*	*
5. *minima*	*	*	*	*	*
6. *Americana*					
7. *Campbelliana*					
8. *nigrella*	?		(France)	*	
9. *Catalinae*					
10. *crystallina*	*	?	*	*	*
11. *Targionia hypophylla*		*	*	*	
12. *Clevea hyalina*	? (Greenland)		*	*	
13. *Clevea hyalina Californica*					
14. *Reboulia hemisphaerica*	*	*	*	*	*
15. *Grimaldia Californica*					
16. *Cryptomitrium tenerum*					
17. *Asterella Californica*					
18. *Bolanderi*					
19. *viola'cea*					
20. *Palmeri*					
21. *gracilis*	? (Greenland)		*	*	*
22. *Conocephalum conicum*	*	*	*	*	*
23. *Lunularia cruciata*	*	*	*	*	
24. *Marchantia polymorpha*	*	*	*	*	*
25. *Sphaerocarpus Californicus*					
26. *cristatus*					
27. *Geothallus tuberosus*					
28. *Riccardia pinguis*	*	*	*	*	*

*We accept here the view of M. Heeg of Vienna (Bot. Not. 1898 : 111–116 1898) that the originally American *Riccia Lescuriana* occurs also in Europe. We have not been able, however, to make a critical comparison of the American and European forms.

	California.	Eastern U. S. (Gray's Manual Region).	British Isles.	Northern and Central Europe.	Mediterranean Region.	Northern Asia (Siberia, China and Japan).
29.	*Riccardia major*	*	*	*	*	* (?)
30.	*multifida ambrosioides*	*	*	*	*	* (?)
31.	*latifrons*	*	*	*	*	*
32.	*palmata*	*	*	*	*	*
33.	*Pellia Neesiana*	?	?	*	*	*
34.	*Blasia pusilla*	*	*	*	*	*
35.	*Fossombronia longiseta*					
36.	*Marsupella emarginata*	*	*	*	*	*
37.	*Bolanderi*					
38.	*Nardia crenulata*	*	*	*	*	*
39	*obovata*		*	*	*	
40.	*Gyrothyra Underwoodiana*					
41.	*Jungermannia Bolanderi*					
42.	*pumila*	*	*	*	*	*
43.	*Danicola*					
44.	*Lophozia incisa*	*	*	*	*	*
45.	*ventricosa*	*	*	*	*	*
46.	*heterocolpa*	*	?	*	*	*
47.	*inflata*	*	*	*	*	*
48.	*ovata*		*	*		
49.	*Plagiochila asplenioides*	*	*	*	*	*
50.	*Lophocolea cuspidata*	?	*	*	*	
51.	*heterophylla*	*	*	*	*	*
52.	*Chiloscyphus polyanthos*	*	*	*	*	*
53.	*Geocalyx graveolens*	*	*	*	*	*
54.	*Cephalozia bicuspidata*	*	*	*	*	*
55.	*pleniceps*	*		*	*	*
56.	*media*	*	*	*	*	*
57.	*divaricata*	*	*	*	*	*
58.	*Turneri*		*	(France)	*	
59.	*Kantia trichomanis*	*	*	*	*	*
60.	*Lepidozia reptans*	*	*	*	*	*
61.	*Blepharostoma trichophyllum*	*	*	*	*	*

	California.	Eastern U. S. (Gray's Manual Region).	British Isles.	Northern and Central Europe.	Mediterranean Region.	Northern Asia (Siberia, China and Japan).
62.	*Blepharostoma arachnoideum*					
63.	*Anthelia Juratzkana*		*	*	*	*
64.	*Ptilidium Californicum*					
65.	*Scapania Bolanderi*					?
66.	*nemorosa*	*	*	*	*	?
67.	*Oakesii*	*				
68.	*undulata*	*	*	*	*	*
69.	*umbrosa*	*	*	*	*	
70.	*curta*	?	*	*	*	*
71.	*heterophylla*					
72.	*Radula Bolanderi*					
73.	*comp anata*	*	*	*	*	*
74.	*Porella Bolanderi*					
75.	*rivularis*	*	*	*	*	
76.	*Roellii*					
77.	*navicularis*					
78.	*Frullania Catalinae*					
79.	*Bolanderi*					
80.	*Nisquallensis*					
81.	*Franciscana*					
82.	*Californica*					
83.	*Anthoceros phymatodes*					
84.	*Pear oni*					
85.	*Carolinianus occidentalis*					
86.	*fusiformis*					
	Totals	37	40	46	46	36

dichotomus are represented on the Californian coast by the close analogues, *Porella Roellii*, *Riccia trichocarpa* and *Anthoceros phymatodes*, their nearest relatives in the eastern United States being much farther removed; again, a species may be very common in Europe and very rare in California or, *vice versa*; and facts like these are wholly lost sight of in merely numerical comparisons of what we choose to regard as species. A few special considerations serve to emphasize the affinity of the California hepatic flora with that of Europe, particularly with that of the Mediterranean region. We have, to begin with, five species of the genus *Asterella* in California and the same number in Italy. In the eastern United States there is but one representative of this genus. Ten species of *Riccia* —a genus which seems to find its best development in southern Europe and northern Africa—are known to occur in California. Of these, one cannot be distinguished from a species otherwise known only in southern France and Italy, and one or two others are closely allied to species peculiar to the same regions. *Targionia hypophylla*, too, is another link in the chain that binds California to the warmer parts of Europe. This genus is absent in the eastern states, but what seems to be the very same species is found sparingly in the British Isles and central Europe, is more common in northern Italy, and is said to become very abundant in the southern portion of the peninsula. One rather common Californian hepatic seems to be identical with *Cephalozia Turneri*—one of the rarest of the Old World species, occurring in limited quantity at a few localities in the British Isles, France, the Canaries, Corsica and Algeria. No stations for this plant intermediate between California and the Old World are known, but it has been collected near San Diego and there is a probability that this species, like *Targionia hypophylla*, will be found to extend into Mexico. *Targionia* is represented in Mexico by two forms which were once considered distinct species but which have recently been reduced by Herr Stephani* to *T. hypophylla*. The presence of this peculiar genus *Targionia* in Mexico, the Canary Islands and Africa, and its absence, so far as is known, in eastern Asia suggest the possibility of some prehistoric land communication across what is now the Atlantic Ocean. The possibility of spores or entire plants finding their way across

* Bull. Herb. Boiss. 6: 764. 1898.

any extended portion of the sea and retaining their vitality seems very remote.

A departure from the customary classification is made in the treatment of the Anthocerotales. The commonly accepted arrangement recognizes two *classes*—the *Hepaticae* and the *Musci*—in the *phylum* or *subkingdom* BRYOPHYTA, though by some writers the *Sphagnaceae* are taken out from the *Musci* and made a separate class. Under the class *Hepaticae* are ordinarily recognized the three orders *Marchantiales*, *Jungermanniales*, and *Anthocerotales*. The last-named group differs from the Hepaticae proper in very important characters and we think these differences are best emphasized by raising the *Anthocerotales* to the rank of a class (under the name ANTHOCEROTES), coördinate with the Hepaticae, restricting this last term to the *Marchantiales* and *Jungermanniales*. This idea is not wholly a new one. Students of plant morphology, among whom Professor D. H. Campbell may be especially mentioned, have been approaching this view for several years, and this position was definitely taken by Mons. L. A. Gayet* in 1897 as a result of investigations on the archegonium alone, though the class was not named and defined by him in the normal systematic way. The peculiarities of the ANTHOCEROTES, briefly enumerated, are: (1) A single large chloroplast to each cell, instead of several smaller chloroplasts as in the assimilative tissues of the Hepaticae proper. Chlorophyll bodies like these—solitary in the cell—are known to occur elsewhere only in certain green algae and in certain tissues of *Selaginella*.† (2) The antheridia arise within the thallus—are endogenous in origin—and the walls of the immersed archegonia are confluent with the adjacent tissues. (3) The presence of meristematic tissue in the capsule near its base, by the activity of which the capsule has a long continued growth, ripening spores toward its apex while forming new spore-mother-cells below. (4) The presence, in probably all cases, of a columella around which the archesporium is formed. (5) The presence, in many cases, of stomata on the capsule, with accompanying assimilative tissue. These five characters are peculiar to the Anthocerotes as distinguished from the Hepaticae proper

* Ann. Sci. Nat. Bot. VIII. 3: 243, 244. 1897.

† Campbell, D. H. The Structure and Development of Mosses and Ferns, 115. 1895.

and they are characters of much significance. For analogies we must look chiefly in two directions—toward the Pteridophyta and toward the Musci.

The principal list of Californian Hepaticae and Anthocerotes hitherto published is that of Dr. Bolander, who included thirty species belonging to these two groups in his "Catalogue of the Plants Growing in the Vicinity of San Francisco."* Dr. Sereno Watson and Mr. Coe F. Austin prepared a manuscript descriptive of the Hepaticae and Anthocerotes of California for incorporation in the volumes devoted to botany in the Report of the Geological Survey of California, but for some reason it never saw the light. This manuscript, in which forty species are diagnosed, is now owned by Professor Underwood and has been accessible. At the end of the present paper will be found a list of the existing literature bearing directly upon the hepaticology of California and also a list of other hepaticological works which have been of the most service in the preparation of this paper.

With the hope of making the paper more useful to beginners in the study of the Pacific Coast Hepaticae, keys to the genera and species have been supplied. In the matter of synonymy and bibliography, no attempt is made to give anything beyond the most important references. Exsiccatae are cited only when Californian specimens are involved. In regard to nomenclature, the Rochester Code is applied in general, though perhaps not always rigidly and consistently; apparent exceptions are discussed under *Grimaldia*, *Lepidozia*, and *Asterella Californica*.

It has been our aim to distinguish as clearly as possible between statements based upon our own observations and those based upon the recorded observations of others, yet borrowings doubtless exist on the following pages, particularly in the diagnoses of genera, which are not expressly acknowledged to be such at the place of their occurrence. In framing definitions of genera, we have been assisted especially by the writings of Spruce, Schiffner, Lindberg, and Limpricht.

Whatever of value the present work may possess is largely due to the encouragement received from Professor L. M. Underwood, whose library, herbarium, and mature experience have been re-

* California Medical Gazette, May, 1870.

sources ever most generously placed at our command. In addition to the friends already mentioned, who have communicated Californian specimens, our thanks are due to numerous others who have kindly loaned types or sent specimens for comparison. We are especially indebted in this way to Mr. W. H. Pearson, Professor F. E. Weiss, Herr F. Stephani, Dr. B. L. Robinson, Dr. E. Lévier, Dr. H. W. Arnell, Sir W. T. Thiselton-Dyer, Professor C. G. Limpricht, Dr. Harald Lindberg, Herr M. Heeg, Mr. Matthew B. Slater, Dr. Alexander W. Evans, Professor Romualdo Pirotta, Professor Günther Ritter von Beck, Mr. O. F. Cook and Mons. P. Hariot.

Class HEPATICAE.

Protonema very small, often rudimentary. Gametophore thallose or foliose or, in a few genera, of a character intermediate between these two types, mostly dorsiventral. Leaves, when present, composed of a single layer of cells, never with a true midvein, arranged upon the stem in two lateral ranks,* with sometimes a more or less well-developed ventral (third) rank. Root-hairs unicellular. Chloroplasts small, several or many in a cell in the assimilative parts. Antheridia and archegonia arising each from the subdivisions of a surface cell; archegonium individualized, its wall (except, rarely, the basal portion of the venter) always free from the adjacent tissues.

Sporogonium permanently enclosed within the modified archegonium wall (calyptra) or more frequently included until the capsule is nearly mature, when the calyptra is ruptured near the top by the growth of the capsule or by the elongation of the seta. Capsule without columella and without stomata, irregularly dehiscent, operculate, or more often opening by (usually) four valves. Spores ripening simultaneously, accompanied (except in *Ricciaceae*) by elongated, thin-walled sterile cells which (with rare exceptions) are provided with spiral thickenings (when each sterile cell is known as an elater).

Order I. MARCHANTIALES. †

Gametophore a thallus, consisting of several distinct layers of tissue, the usually clearly defined dorsal epidermis ‡ containing pores ("stomata" §) which communicate with narrow vertical

* Except in a very few genera, none of which are known to occur in California.

† For diagnosis of Order II, *Jungermanniales*, see page 62.

‡ *Dumortiera*, not yet found in California, has a very exceptional thallus, being without perceptibly differentiated epidermis, pores, or air-chambers.

§ The so-called "stomata" of the gametophore of the Marchantiales are quite different in structure from the stomata of the sporophyte in the *Anthocerotes*, *Musci*, *Pteridophyta*, and *Spermatophyta*, and are, perhaps, only in part analogous in function. But "stoma" as applied to the "breathing pore," together with its more or less modified epidermal surroundings, is a convenient term in the description of the Marchantiales and the use of the word in this extended sense is sanctioned by Lindberg, Schiffner, Stephani, and others.

canals or enlarged air-chambers in the subjacent chlorophyll-bearing layer and are often bounded by specialized epidermal cells. Ventral surface mostly provided with scales arranged in longitudinal rows. Root-hairs of two forms upon the same plant, the one with smooth walls, the other with interior peg-like papillae. Sexual organs aggregated in specialized parts of the thallus or on modified branches, or in the lower forms irregularly scattered.

The first four segments of the embryo sporogonium arranged like the quadrants of a sphere. Matured sporogonium consisting of a capsule without stalk or foot, all of the interior cells forming spores, or of capsule, foot, and short seta (rarely attaining length of 1–2 mm.), when some of the interior cells produce elaters.

The order Marchantiales comprises the two families *Ricciaceae* (see below) and *Marchantiaceae* (see page 34.)

Family I. RICCIACEAE.

Gametophyte a carnose, dichotomously branched or rarely subsimple thallus; chlorophyll-bearing tissues of suberect lamellae enclosing very narrow and inconspicuous subvertical air-canals or more ample chambers, these unoccupied by a specialized assimilative tissue. Stomata rudimentary, rarely well-developed. Ventral scales mostly present but sometimes obscure. Sexual organs arising singly from the dorsal surface just back of the growing apex, soon becoming deeply immersed in the thallus, the elongated archegonium-neck commonly exserted, the walls of the efferent canal of the antheridial cavity often produced into a conico-cylindrical elevation.

Sporophyte a capsule, without foot or seta, always enclosed by the calyptra, in which the spores come to lie at maturity through the disappearance of the delicate capsule-wall. Inner cells all producing spores.

1. RICCIA L. Sp. Pl. 1138. 1753. Ex Mich. Nov. Pl. Gen. 106. 1729.

Plants terrestrial, or rarely aquatic, often forming rosettes or half-rosettes, with linear, ovate, or cordate lobes, usually closely attached to the soil by root-hairs, the latter either smooth-walled or furnished with peg-like protuberances from the wall into the

lumen, thallus-segments commonly with a distinct median sulcus on dorsal surface; lamellae of the chlorophyll-bearing layer enclosing very narrow subvertical air-canals or less commonly larger chambers, the latter when present often breaking through to the surface, giving the thallus a spongy or lacunose appearance; ventral portions (costa) of the thallus composed of parenchymatous cells nearly or wholly destitute of chlorophyll; a rather poorly defined layer of somewhat prosenchymatous starch-bearing cells sometimes distinguishable between the chlorophyll-bearing and ventral strata; cells of the primarily superficial layer of the dorsal epidermis often soon collapsed and more or less disintegrated. Stomata represented by small pores surrounded by slightly or not at all modified epidermal cells. Scales hyaline-albescent, brownish-violet, or dark-purple, often fugacious,* rarely surpassing the margins of the thallus, originating in a single † median series, soon ruptured along the median line and becoming apparently two-ranked. Monoicous or dioicous. Sexual organs scattered, the antheridia irregularly intermingled with the archegonia in the monoicous species.‡ Involucre none. Capsules immersed. Spores large, for the most part distinctly tetrahedral, the surface marked with free or most frequently mesh-forming ridges, the angles of the areolae often with papilliform elevations, or the inner (plane) spore-faces sometimes simply punctate.

Key to the Species.

Thallus "solid," *i. e.*, with very narrow vertical or subvertical air-canals which communicate only inconspicuously with the dorsal surface.

Thallus furnished with scales underneath, not ciliate-margined.

Scales extending considerably beyond the margin, whitish-hyaline; spores immarginate, obscurely angular, 90–126 μ in maximum diameter.

6. *R. Americana.*

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* *R. crystallina* L. is said to have no traces of scales even as rudiments. They are scarcely distinguishable in some of the other Californian species.

† Herr Stephani, contrary to the usually accepted view, states (Bull. Herb. Boiss. 6: 311. 1898) that doubtless most *Ricciae* have an originally *double* series of scales. In all the Californian species which we have been able to subject to microtome sectioning, viz., *RR. Americana, nigrella, minima, trichocarpa, Californica,* and *Campbelliana,* the younger scales are clearly seen in a transverse section to extend uninterruptedly across the median line and to be attached to the body of the thallus on either side; later they become biseriate by a median longitudinal rupture.

‡ Professor Campbell has found in his researches on the development of the sexual organs in the Californian *Ricciae* that "several of one sort or the other would be formed in succession." We have sometimes had difficulty in finding anything but archegonia in species that could at other times be clearly shown to be monoicous.

Scales not reaching margin or rarely slightly exceeding it at thallus-apex.

Scales blackish-purple; thallus-segments 1–1.5 mm. wide; antheridial ostioles scarcely or not at all elevated. 8. *R. nigrella.*

Scales brown or nearly colorless, usually inconspicuous; thallus-segments 1–3 mm. (mostly 1.5–2 mm.) wide; antheridial ostioles prominent, conico-cylindrical. 7. *R. Campbelliana.*

Scales hardly distinguishable unless at thallus-apex, whitish or hyaline; thallus-segments mostly 1–2 mm. wide; ostioles elevated about .08 mm.; superficial epidermal cells soon becoming cup-like by disappearance of the upper portion of their wall; plane faces of the spores merely punctate or marked with numerous low mostly free ridges. 5. *R. minima.*

Thallus ciliate on margins or at apex.

Thallus-segments .75–1.5 mm. (mostly 1 mm.) wide, the margins densely ciliate; 1–12 cilia, with rare exceptions, springing from the dorsal epidermis above each capsule; spores soon black and very opaque, 90–120 μ in maximum diameter. 2. *R. trichocarpa.*

Thallus-segments 1–2 mm. wide, bearing few or numerous short cilia on margins toward apex but none on dorsal surface; antheridial ostioles not elevated; spores brown, 70–90 μ in maximum diameter, meshes of convex face 6–10 μ in width. 3. *R. Californica.*

Thallus-segments 2–2.5 mm. wide, the margins bearing a few short stout cilia; ostioles conico-cylindrical, .1–.2 mm. high; spores * 90–118 μ in maximum diameter. 1. *R. Lescuriana.*

Thallus naked on margins and underneath or with very rudimentary scales, very rarely with rudimentary cilia toward apex; antheridial ostioles conico-cylindrical; plane-faces of the spores reticulate-areolate, meshes of the convex face 10–15 μ in width. 4. *R. glauca.*

Thallus with large air-chambers which finally communicate conspicuously with the dorsal surface, giving thallus a spongiose or vesiculose-alveolate appearance.

Thallus light-green, rather loosely attached to the soil, very thin, the transverse sections at least six times broader than high; spores 90–108 μ in maximum diameter, with a margin 4–10 μ wide. 9. *R. Catalinae.*

Thallus often yellowish-green, very closely adherent to the soil, transverse sections of the segments 2.5–4 times broader than high; spores 60–90 μ in maximum diameter, with a narrow (sometimes almost deficient) margin 3–5 μ in width. 10. *R. crystallina.*

1. RICCIA LESCURIANA Aust. Proc. Acad. Nat. Sci. Philad. 1869: 232. 1869.

Thallus light green and reticulate above, concolorous below, or tinged with purple at margins, orbicular or semiorbicular in general outline; the principal divisions few, with a wide-angled (30° 90°) dichotomy 1–3 times repeated or subcruciately lobed, 6–10 mm. × 2–2.5 mm., mostly linear-obcuneate, the shorter sometimes nearly obcordate; terminal segments ovate-elliptical to

* See remarks on the size of the spores of the Californian *R. Lescuriana.*

oblong, subacute, with a few usually quite inconspicuous hyaline or whitish ventral scales at the apex, the flat-bottomed median sulcus occupying about one third their width but narrowed and apparently closed in front by the convergence of the abruptly ascending margins, these often incurved on drying, somewhat incrassate, though commonly subacute in cross-section, bearing in a single or double series a few stout obtuse or sharp-pointed cilia .1–.3 mm. long; transverse sections rounded ventrally, their width 2–3 times their height, about 20 cells thick in median parts, the air-chambers narrow; cells of the superficial layer of the epidermis soon collapsed and disintegrated or irregularly persisting as cups attached to the cells below: monoicous: antheridia abundant, their ostioles prominent, conic-cylindrical, .1–.2 mm. high: capsules with a naked, sometimes purple thallus-covering; spores brown, 75–118 μ in maximum diameter, angular, with a slightly granulate, more or less interrupted margin 3–12 μ in width, the outer face lightly papillate or nearly smooth in profile, 8 or 9 strongly defined areolae measuring its diameter, the inner faces a little less distinctly areolate or marked with ridges which scarcely anastomose.

On the bank of a rivulet, Fort Ross, Sonoma County, March 15, 1896.

The Californian plant differs from the typical *R. Lescuriana* chiefly in the larger spores (90–118 μ in the former; 75–100 μ in the latter) which are also more distinctly areolate on the inner faces. The thallus-margins and the thallus-covering of the capsules, too, show less purple than Mr. Austin's original plants from New Jersey, but these differences, we think, are not sufficiently important to be considered specific. Specimens collected at Jacksonville, Florida, by J. Donnell Smith in 1877, agree essentially with the Fort Ross plant. *Riccia Lescuriana* is perhaps more likely to be confused with *R. Californica* than with any of the other Californian *Ricciae*, from which, however, it may be easily distinguished by the larger spores, the prominent antheridial ostioles, the shorter, stouter cilia, etc.

We would place, for the present, with the above species a somewhat anomalous *Riccia* collected in California by Bolander (in herb. Underwood, from U. S. National Museum). The thallus is but once forked and unusually thin, the transverse sections being 4–6 times as wide as high; the cilia are rudimentary or wanting; the spores have more numerous and smaller areolae, 10–12

measuring the diameter of the convex face. Its large spores (90–105 μ), the broad divergent thallus-lobes and other minor characters stand in the way of its reference to *R. glauca*.

2. RICCIA TRICHOCARPA M. A. Howe, Bull. Torr. Bot. Club, **25**: 184. *pl. 337*. 1898.

Thallus in rosettes about 2 cm. in diameter or forming somewhat irregularly radiating masses; the principal divisions linear, 2–6 times dichotomous, .75–1.5 (mostly 1) mm. in width, often black below and at margins, densely clothed at the sides with white or tawny setae .3–.65 mm. long, those toward the apices often in as many as 8–12 irregular series, mostly distinct at insertion, with sharp, rigid, rarely slightly uncinate points, the terminal thallus-lobes obcuneate or oblong-elliptical, obtuse or subacute, narrowly and rather deeply unicanaliculate toward the apices or subbicanaliculate, the furrow at the extremities commonly concealed by the trichomes, the median sulcus sometimes nearly vanishing toward the base, margins obtusely rounded, tumid, often connivent on drying, the furrow then thatched by the somewhat forwardly directed setae; dorsal surface light green, minutely and regularly reticulate; ventral surface nearly plane and flat, with a few very inconspicuous scales on either side of the median line at the apices, falsely squamose in the basal parts through delamination due to marcescence; width of transverse sections 1.6–3 times their height, the posterior subquadrangular with a light median sulcus, the margins becoming more tumid and rounded in proceeding toward the apex and the sulcus now and then double, the sections convex ventrally only in the extreme apical region; 20–28 cells in thickness in median parts, texture nearly solid, the air-chambers narrow and vertical; epidermis primarily bistratose, the superficial layer at first papillate, afterwards collapsed, and in the older parts reduced to a flattened cellulose membrane incumbent on the lower layer: monoicous: antheridia scattered, the ostioles elevated about .1 mm.: sporogonia numerous, in a single or double series, immersed, finally—especially when dry—hemispherical-protuberant above, together with the long-unruptured covering, or subconical, the covering marked with a dark-purple spot and bearing with rare exceptions 1–12 setae; spores soon black and very opaque, narrowly or not at all margined, 90–120 μ in maximum diameter, minutely granulose-papillate, with 9–12 areolae (visible only in the younger spores) across the convex face, the walls of these with irregularly thickened and salient angles, thus often giving this face in profile the appearance of bearing columnar or wart-like elevations, areolae across one of the plane faces 5–7 in number, scarcely elevated at the angles.

EXSICC. Hep. Bor.-Am. 143[b] (as *R. tumida* Lindenb.).
Hep. Am. 138* (as *R. arvensis* Aust., var. *hirta* Aust.).

On rather dry and rocky soil. About San Francisco, "Mission Dolores," "Turk St.," "near Ocean House" (Dr. Bolander), Mission Dolores (Howe); Berkeley (Howe); Ukiah (Howe); near Stanford University† (Prof. D. H. Campbell, Palo Alto (S. E. Brown); Santa Ana Hills (Parish); Pasadena (McClatchie); San Diego (Mrs. Katharine Brandegee).

The above is the Californian *Riccia* that has been referred variously by American authors to *Riccia ciliata* Hoffm., *R. tumida* Lindenb., *R. intumescens* Aust. MS., Underw. (*R. ciliata* Hoffm., var. *intumescens* Bisch.) and more recently to *Riccia hirta* Aust. (*R. arvensis* Aust., var. *hirta* Aust.). But *Riccia arvensis hirta** known only from Mr. Austin's specimens from the neighborhood of Closter, New Jersey, bears comparatively few, short, usually blunt-pointed and incurved papilla-like cilia .1–.3 mm. long (not *setae*), the thallus is strongly incrassate-carinate ventrally, the margins are acute, the epidermis is very thick, of 2 or 3 layers of decolorate or purple-tinged cells, the somewhat smaller, more distinctly margined spores are fuscous-brown at maturity and always show their areolae quite clearly in glycerine instead of being densely black and opaque as in *R. trichocarpa* under the same treatment, the plants are mainly smaller and less frequently dichotomous, the thallus-segments are usually comparatively broader, reddish-purple below and more evidently squamigerous.

A much nearer ally of *Riccia trichocarpa* is doubtless *R. ciliata* Hoffm. of Europe. From the typical form of this, however, the Californian plant is clearly distinct in the shorter and much more abundant setae (these often reach 1 mm. in length in *R. ciliata*), in the presence of trichomes over the sporogonia, in the rather larger size of the thallus, more acute-angled dichotomy, and in the commonly black margins and sides. From *R. ciliata intumescens*

* See footnote, Bull. Torr. Bot. Club, 25 : 186. 1898.

† Professor Campbell's specimens, which we took as the type of this species, were distributed in the Hep. Am., by error, as having been collected in San Mateo Co., and this locality was copied in connection with our original description. We are informed, however, by Prof. Campbell, that the specimens came from Santa Clara Co., near the San Mateo Co. line.

Bisch. known to us only from the excellent figures and description of its author and from a specimen communicated by Herr M. Heeg, our plant differs in the longer, narrower segments, in the shorter and even more crowded lateral setae, those toward the apex often in as many as 8–12 irregular series, and in the normal presence of 1–12 long trichomes above each sporogonium, while in *R. ciliata intumescens*, the "cilia" appear to be of somewhat rare occurrence on the dorsal surface. In *R. ciliata*, the tissues covering the mature sporogonium soon become thin, scarious, and shining, and finally break away in fragments, exposing the capsule and the spores, and Bischoff* remarks of the capsules of the var. *intumescens*: "*post maturitatem rupti, foveolas sporis repletas in frondis pagina superiore relinquentes*"; while in *R. trichocarpa* the covering of the capsules remains very long intact—indeed, in only one case out of several specimens with spores evidently much past maturity, have we seen the contents of a capsule exposed by natural agencies.

Riccia crinita Tayl. from Swan River, Australia (Drummond, no. 42), the original of which we have seen through the kindness of Dr. B. L. Robinson, is close to *R. trichocarpa* in character and number of setae, which also sometimes occur over the sporogonia. But *R. crinita* is a smaller plant, only 2 or 3 times dichotomous, with shorter, oblong rather than linear segments, the thallus is comparatively much thinner, the vertical sections of its segments being 3–7 times as wide as high, the margins are acute and commonly incurved; the spores (possibly not arrived at full depth of color) are light-brown, 75–90 μ in maximum diameter, with 11–14 smaller areolae across the convex face, this scarcely papillate in profile, the plane faces similarly areolate, the mesh-forming ridges throughout and the narrow margin nearly smooth.

Riccia Michelii Raddi, var. *ciliaris* Levier (=*R. tumida* Lindenb. and *R. palmata* Lindenb. *fide* Levier) differs so widely from our species that a detailed comparison is unnecessary.

R. trichocarpa may be found with archegonia and antheridia in January and early February, ripening its capsules in April and May. Like all the Californian *Ricciae* it is practically invisible during the summer months.

* Acta Acad. Caes. Leop.-Carol. Nat. Cur. 17: 1063. 1835.

PLATE 88. RICCIA TRICHOCARPA.

1 and 2. Portions of the plant, natural size.

3. Terminal segments of a young thallus, dorsal view, × 5.

4. End of thallus lobe from fig. 1, with ostioles and a sporogonium, × 10.

5. Lateral view toward apex of a thallus-segment, showing the numerous trichomes, × 20.

6. Marginal trichomes, × 53.

7. Portions of thallus exhibiting the trichome-bearing elevations above the capsules, × 20.

8–13. Outlines of transverse sections about 10 μ in thickness at selected points from near the apex to the old and shriveled base, × 23. The trichomes do not appear so abundant as might be expected from the material used for microtome sectioning, which may be explained from the thinness of the sections and by the fact that the detached sections and fragments of the trichomes have not always adhered to the glass slides. Fig. 8 shows small median scales.

14. Epidermis and subjacent cells from a younger portion of the thallus, × 225. The superficial layer is here represented as composed of collapsed cells. In the extreme apical region only they are papilliform.

15. Epidermis in older parts of the thallus, × 225. The collapse and disintegration of the cells of the outer layer is so complete that only a structureless cellulose film remains.

16. Cross-section of thallus showing the cell structure and a young sporogonium, × 53.

17. Spores, × 305.

Figs. 1, 2, 4–7 and 17 from Hep. Am. no. 138 collected near Stanford University, April, 1892, by Prof. D. H. Campbell; figs. 3 and 8–16 from material fixed with 1 percent. chromic acid and preserved in alcohol, collected by the author near Berkeley, California, February 8, 1896.

3. RICCIA CALIFORNICA Aust. Bull. Torr. Bot. Club, 6:46. 1875.

Thallus forming light green, somewhat glaucescent rosettes 8–18 mm. in diameter, concolorous beneath, reticulate above, often minutely puberulent or scurfy when moistened; the principal divisions 1–3 times dichotomous; terminal segments short-oblong or obovate, 1–2 mm. wide, bearing toward the subtruncate or retuse apex few or numerous whitish or subfuscous, mostly slender and sharp-pointed cilia .16–.4 mm. in length, the commonly obtuse margins elevated and somewhat tumid when young, the median sulcus broad and obtuse except at the extreme apex, vanishing backward, the segments more or less concave dorsally on drying, rarely nearly plane, scales very rudimentary (none in the ordinary sense); width of transverse sections 2–5 times their height, thickness of thallus 15–25 cells in median parts, the upper layers of cells chlorophyllose, the lower often nearly or quite destitute of contents, air-chambers narrow and vertical; cells of the superficial layer of the epidermis hemispherical-convex or papilliform near the growing apex of the thallus, soon collapsed or disintegrated, per-

sisting only as imperfect and irregular cups or more often as mere wall-fragments adhering to the hyaline and nearly empty cells of the primitively lower layer: monoicous: antheridia infrequent, the ostioles not elevated above the surface of the thallus: archegonium-neck exserted and often conspicuous even at maturity of the sporogonium: capsules deeply immersed, with a naked long unruptured covering, in rare cases exploded-protuberant with age; spores brown, finally darkening but always more or less translucent, 70–90 μ in maximum diameter, distinctly angular, with a smooth yellow or brownish irregularly crenate margin 3–12 μ in width, the diameter of the outer face measured by 10–13 areolae, these mostly 6–10 μ in width, the papilliform elevations at the angles of the meshes 3–4 μ or less in height when seen in profile, the inner faces with similar but less papilliform-angled areolae.

On lightly shaded banks. "California" (Dr. Bolander; the original specimens in Herb. Pearson). Berkeley (Howe), Fruit Vale (Miss Edith S. Byxbee); Clarendon Heights, San Francisco (530*), and near the Mission Dolores (512); Ukiah, Mendocino Co. (783); Silver Lake, Alpine Co. (Geo. Hansen).

The cilia in this species are occasionally reduced and inconspicuous, but are always present, we believe, even though sometimes only in a rudimentary form.

Riccia subinermis Lindb. (1881), of which we have been allowed to see authentic specimens through the kindness of Mr. Harald Lindberg and specimens of which we also owe to Herr M. Heeg, differs from *R. Californica* in the usually much shorter and less numerous cilia, in the elevated conico-cylindrical antheridial ostioles, in the larger meshes of the outer face of the spores, in the less regular areolation of the inner faces, etc. The areolae of the outer face in *R. subinermis* and *R. glauca* are mostly 10–15 μ in width, while in *R. Californica* they are usually only 6–10 μ wide. We agree with Dr. Levier and others in thinking *Riccia subinermis* doubtfully distinct from *R. glauca*.

PLATE 89. RICCIA CALIFORNICA.

1. The plant, natural size, from a dried specimen.
2. Two of the principal segments of the thallus, from alcoholic material, $\times$ 5.
3. A portion of Austin's original plant (soaked out), *ex herb.* Pearson, $\times$ 5.
4–8. Outlines of transverse sections of a principal segment at somewhat regular intervals, passing from near apex toward the base, $\times$ 23.

* The numbers refer to specimens collected by the author.

9. Transverse section near the middle of a principal segment of another plant, × 23.

10. From same segment as fig. 9, but near the base, × 23.

11. Epidermal cells from near the thallus-apex, × 225.

12. Epidermis from an older part of the thallus, showing remnants of the primitive surface-layer, × 225.

13. Marginal trichomes, × 53.

14. Transverse section of thallus, × 53.

15. Spore, showing the inner (plane) faces, × 305.

16. Spore, showing the outer (convex) face, × 305.

Figs. 1, 2, 9, 10 and 12 from no. 530, Clarendon Heights, San Francisco; fig. 3, from Mr. Austin's original, *ex herb.* Pearson; figs. 11, 13, 14–16 from material collected at Fruit Vale, by Miss Edith S. Byxbee; figs. 2 and 4–14 from material fixed with 1% chromic acid and preserved in alcohol.

4. RICCIA GLAUCA L. *pro parte maxima* Sp. Pl. 1139. 1753.

Differs from *R. Californica* chiefly in the normal absence of cilia, the presence of cylindrical or conico-cylindrical antheridial ostioles projecting about .1 mm. above the surface of the thallus, and in having the meshes of the outer face of the spore 10–15 μ in width.

Little Bear Valley, San Bernardino Mts. (S. B. Parish, no. 1670, Aug. 1884, in herb. Underwood); near Mineral King, Tulare Co. (Coville and Funston, Death Valley Expedition, no. 1509, Aug. 6, 1891).

Mr. Parish's plant differs from the larger forms of the European *R. glauca* in nothing, we think, but the rather smaller meshes of the convex face of the spore, which, in this specimen, are commonly only about 10 μ in width. The specimen from Tulare Co., while exhibiting the ostioles of *R. glauca*, has now and then rudimentary cilia toward the thallus-apex and would doubtless be identified with the *Riccia subinermis* Lindb. of Europe by those who maintain this as a species.

It may be remarked that according to the drawings of Herr Waldner* one might gain the impression that the ostioles of *Riccia glauca* are scarcely elevated above the general surface of the thallus, but it is probable that the antheridium in even the most advanced stages represented by Waldner was still far from maturity. The "Antheridienstifte" of *R. glauca* are described by Limpricht† as "walzenförmig vortretend" and we find them thus (.1 mm. long) in G. & R. Hep. Eur. no. 646.

* Leitgeb, Untersuch. über d. Leberm. Heft 4. *pl. 2. f. 4–6.*

† Cohn, Krypt.-Fl. v. Schles. 1: 349. 1877.

5. RICCIA MINIMA L. *p. p.* Sp. Pl. 1139. 1753.

Riccia sorocarpa Bisch. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **17**: 1053. 1835.

Thallus at first subradiate, forming later irregularly gregarious patches, of a bright, clear, subcrystalline light green (not puberulent or scurfy) when living or when soaked out with water, of a lighter green when dry, minutely, regularly, and compactly reticulate above when moistened, sometimes nearly smooth on drying, concolorous below; the principal divisions 4–7 mm. long, bifid or once or twice dichotomous; the terminal segments oblong, .75–2 mm. wide, subacute, carinate-incrassate, with an acute median furrow and naked, ascending, for the most part sharply acute, often hyaline and submembranous margins, furnished beneath toward the apex with small whitish or hyaline scales, these often reaching the margin but not surpassing it, the margins commonly elevated or somewhat incurved on drying; transverse section parabolic or subquadrate, its width 1–4 times its height, about 25 cells thick in median parts, air-chambers narrow; epidermis of two or three layers of cells, those of the superficial stratum at first papilliform, the lower portion of their wall becoming thickened and the upper soon vanishing, leaving behind persistent cups attached to the likewise thick-walled cells of the subjacent layer: monoicous: antheridia few, the ostioles short-cylindrical, elevated about .08 mm.; capsules usually numerous, with age sometimes emergent-protuberant toward the base of the segments by rupture of the naked covering; spores dark brown, 70–90 μ in maximum diameter, angular, with a brownish granulate-papillate and crenulate, usually interrupted margin 3–6 μ broad, the outer face areolate, 10–12 meshes measuring its diameter, exhibiting in profile papillae mostly 3–6 μ long, the inner faces densely and rather minutely punctate or furnished with very short and numerous low ridges which do not form areolae.

EXSICC. Hep. Am. 139 (as *R. glauca*).

Not uncommon in the coast region, often associated with *R. Californica.*

Berkeley, Oakland, Fruit Vale; Clarendon Heights and near Mission Dolores, San Francisco; Fort Ross, Sonoma Co.; Ukiah (782); Mitchell Cañon, Mt. Diablo; near Stanford University (D. H. Campbell); Pasadena (A. J. McClatchie).

The Californian plant is usually larger than the European specimens that we have seen, yet it very rarely attains the dimensions of representatives of this species collected in Siberia by Dr. H. W.

Arnell, to which Herr M. Heeg refers in the Botaniska Notiser for 1898 (p. 21) and which we have been privileged to examine through the courtesy of Dr. Arnell. The antheridial ostioles in the European plant so far as we have been able to discover them in specimens kindly communicated by Herr Stephani, Herr Heeg, and others, seem to be very slightly or not at all elevated, yet in the Siberian specimens to which allusion has already been made they sometimes attain the height of .12 mm. above the surrounding surface, which is in excess of anything we have observed in the Californian specimens.

In only one case have we noticed the partial exsertion of the sporangium at maturity as figured and emphasized by Bischoff in his original diagnosis of *R. sorocarpa*. In regard to this character Herr Heeg remarks: "die von Bischoff besonders hervorgehobene Berstung der Lauboberfläche bei der Fruchtreife, bezeichnet das Endstadium einer Entwicklungsperiode und wird nur selten gerade in diesem Zustande aufgesammelt." *

6. **Riccia Americana** sp. nov.

Riccia lamellosa Americana M. A. Howe, *p. p.* Bull. Torr. Bot. Club, **25**: 189. 1898.

Thallus rather loosely subradiate or forming compact more or less imbricate masses; principal divisions 5–15 mm. long, 1–3 times dichotomous, very rarely simple, 2.5–4 mm. in greatest width, pale green and regularly reticulate above, concolorous below, acutely and deeply canaliculate toward the apex, 25–30 cells thick in median parts, furnished beneath with large obtuse transverse patent or somewhat imbricate subundulate hyaline scales, these extending considerably beyond the acute or thin-membranous ascending or, when dry, often erect-connivent margins; the transverse sections 1.5–3 times as broad as high; the terminal segments emarginate, oblong to obcordate, mostly obovate; epidermis of two layers of cells, the superficial at first subglobose or oval-papilliform, later collapsed or disintegrated, two or three of the subjacent strata sometimes becoming decolorate: monoicous (polyoicous?): antheridia infrequent, their ostioles not at all or slightly elevated: spores brown, 90–126 μ in maximum diameter, obscurely angular, wholly destitute of a wing-margin, with 8–12 clearly defined areolae, each about 15 μ in width, across the outer face, the inner faces marked with much smaller and much less distinct areolae or simply with irregular vermicular lines.

* Heeg, Bot. Notis. **1898**: 20. 1898.

On exposed or lightly shaded banks, often associated with *R. nigrella*, *R. trichocarpa* and *R. Californica*. San Francisco (Bolander), on hillsides between Mission Dolores and Clarendon Heights, San Francisco (Howe); Fruit Vale (Miss Edith S. Byxbee, Howe).

Riccia Americana is closely related to *R. lamellosa* Raddi, from which, however, it differs very markedly in spore-characters. The European plant has distinctly wing-margined and plainly angular spores and the markings of the inner and outer faces are nearly uniform; the ridges of the outer face are more vermicular than in *R. Americana* and less often form perfect areolae, and when the areolae are well defined, they are smaller and more numerous, 14 or 15 measuring the diameter of the face. The scales in *R. Americana* are more prominent than in *R. lamellosa*. For comparison, we have made use of a specimen from Florence, Italy (the type locality), and one from Sicily, both kindly communicated by Dr. E. Levier.

Riccia Austini Steph. (Bull. Herb. Boiss. **6**: 336. 1898) is a nearer ally in respect to spore-characters, with the exception that the spores are smaller (75–105μ in maximum diameter), but differs in the much thinner and mostly smaller thallus, this being only 14–20 cells in greatest thickness and the breadth of the transverse sections being 3–4 times their height, and in the less conspicuous scales. *R. Americana* seems to occupy a somewhat intermediate position between these two species. In case it should ever be combined with *R. Austini*, this latter name should be employed for the aggregate, inasmuch as it was published, we are informed by Dr. Eugène Autran, editor of the *Bulletin de L'Herbier Boissier*, about two weeks in advance of our *Riccia lamellosa Americana*.

We have been able to see only four or five antheridia in this species though hundreds of sections have been made. In two instances, archegonia occurred on the plants bearing the antheridia; and in two other cases no archegonia were to be discovered, but in the latter cases we were sectioning somewhat fragmentary alcoholic material. The great majority of the plants examined showed archegonia without traces of antheridia.

PLATE 90. RICCIA AMERICANA.

1. Dry plant, natural size.

2. Plants from material preserved in alcohol, natural size.

3. Thallus-segment, alcoholic material, × 5.

4. Thallus-segment, from dry specimen, × 10.

5. A thick free-hand transverse section from near apex of thallus, showing portions of the scales, × 23.

6. Outline of transverse section from same segment as no. 5 but farther back, × 12.

7–9. Outlines of microtome cross-sections of thallus segment; no. 7, near apex, no. 8, well forward, no. 9, toward base, × 12.

10 and 11. Outlines of cross-sections of thallus-segment from another plant, × 12.

12. Antheridium, showing non-elevated ostiole, × 12.

13. Epidermis near thallus-apex, × 225.

14 and 15. Epidermis from older parts, × 225.

16. Ventral scale, × 23.

17. Portion of thin transverse microtome section of thallus, × 53.

18. Outer face of spore, × 305.

19. Inner faces of spore, × 305.

20. Outline of optical section of spore-wall, showing its relative thickness, × 305.

Figs, 1, 4–6, and 18–20, drawn from specimen collected in Fruit Vale, Alameda County, May 2, 1895; 2, 10, 11, and 13–16, San Francisco, April, 11, 1896; 3, 7–9, 12, and 17, Fruit Vale, February 1, 1896.

7. **Riccia Campbelliana** sp. nov.

Thallus mostly once or twice, occasionally three times, dichotomous, rarely subradiate, reticulate above, brown or nearly concolorous below, very rarely blackening, 4–18 mm. long, 1–3 mm. (mostly 1.5–2 mm.) wide, more or less rounded ventrally, sometimes carinate, furnished beneath with brown or nearly colorless scales, these usually inconspicuous, but sometimes at the apex slightly exceeding the thin, naked, membranous, commonly yellowish-brown, now and then rather abruptly winged margins, median sulcus acute, often obscure toward basal parts, the margins, on drying usually ascending, erect, or inflexed-connivent; terminal lobes oblong or obovate, obtuse, less commonly subacute; transverse sections, including margins, 2–5 (mostly 2½) times broader than high, thickness of thallus 25–35 cells in median parts, air-canals narrow; cells, often enlarged, densely filled with a finely granular, yellowish-brown material or with a homogeneous yellow oily substance, sometimes occurring abundantly in all parts of the thallus; epidermis primarily unistratose, the cells large, oblong-elliptical in vertical section or subquadrate-elliptical, mostly higher than broad (40–75 μ × 25–50 μ), long intact, disintegrated in the older parts and replaced by an irregularly developed subjacent layer: spores finally yellowish-brown, 75–108 μ (mostly

90–100 μ) in maximum diameter, distinctly angular, with a minutely granulate or nearly smooth margin 3–6 μ width, the outer face lightly papillate or nearly smooth in profile, marked with close sinuous ridges which rarely form completely closed meshes, the imperfect areolae mostly 4–7 μ in width, inner faces similarly but less strongly marked.

Near Stanford University (Professor D. H. Campbell, Feb. 6 and May 1, 1896); on hills above Mission Dolores (534, April 11, 1896, with *R. nigrella* and *R. trichocarpa*); Fort Ross, Sonoma Co. (March 15, 1896); Ukiah (May 13, 1896). Collected by Professor Campbell also in 1893 (herb. Underwood).

Riccia Campbelliana in its smaller forms simulates to a certain extent *R. nigrella*, with which it is sometimes associated, but is always readily distinguished by the wider and usually longer segments, which are commonly brown underneath, very rarely blackening, by the thinner brown margins, by the larger spores and the elevated antheridial ostioles. The epidermis, too, differs from that of *R. nigrella*, its cells being larger and commonly having their vertical axis longer than the horizontal, while those of *R. nigrella* are subquadrate in vertical section and are quite frequently broader than high, measuring 25–40μ in height by 25–45μ in width.

The larger conditions of this species are somewhat suggestive of *Riccia Bischoffii* Hüben. and *R. Gougetiana* Mont.,* especially when, as sometimes happens, the thallus is rather abruptly wing-margined, but the Californian plant differs clearly from both these in being monoicous, in the usually smaller size, in the entire absence of cilia, in the smaller, lighter colored, much more translucent spores, etc.

Riccia lamellosa Raddi is easily distinguished from the larger forms of *R. Campbelliana* by the much more prominent scales, the usually less attenuate concolorous margins, the different epidermis, three or four layers of cells next to the dorsal surface of the thallus in *R. lamellosa* being commonly echlorophyllose, and by the entire absence, so far as we have observed, of oil-bodies. *R. lamellosa* is described by Herr Stephani† as dioicous and our investigations on Italian material point toward the same conclusion, though we have been able to see no antheridia.

* We have seen an authentic specimen of this from the Montagne Herbarium through the courtesy of Mons. Paul Hariot of the Muséum d'Histoire Naturelle of Paris.

† Bull. Herb. Boiss. 6: 341. 1898.

The specimen collected by Professor Campbell near Stanford University on May 1, 1896, we consider the type of the species. This specimen, so far as we have noticed, does not contain the oil-bodies referred to in the description, but such occur sparingly in the previously collected specimen now preserved in the Underwood Herbarium and are very abundant in alcoholic material from the same locality communicated by Professor Campbell. These are present also in the San Francisco plant, but are sparingly developed or absent in the specimens from Fort Ross and Ukiah. Allusion is made in our remarks under *R. nigrella* to the occasional behavior of the contents of the epidermal cells when treated with iron-haematoxylin.

PLATE 91, FIGS. 1–15. RICCIA CAMPBELLIANA.

1. Plant, dry, natural size.

2 and 3. Plants from soaked-out dried material, natural size.

4. Terminal portion of thallus-segment, × 10.

5–8. Outlines of transverse sections of thallus-segments, × 12.

9. Outline of transverse section of an unusually wing-margined thallus-segment, × 23.

10. Papilliform elevation of antheridial ostiole, × 53.

11 and 12. Thin transverse sections showing epidermis and cells containing "oil-bodies," × 53, the latter section from an older part of the thallus.

13. Cell from older part of thallus containing "oil-body" which here appears densely granular (yellowish-brown in the alcoholic material), × 225. The adjacent cells contain chloroplasts and starch-grains.

14 and 15. Spores, × 305.

Fig. 1 drawn from specimen collected at Fort Ross, March 15, 1896; 2, 9, 14, and 15, near Stanford University (Professor Campbell, May 1, 1896); 3 and 5, near Stanford University (Professor Campbell, February 6, 1896); 4 and 8 (Professor Campbell, 1893, *ex herb.* Underwood); 6, 7, and 10–13, from alcoholic material sent by Professor Campbell.

8. RICCIA NIGRELLA DC. Fl. Fr. **5**: 193. 1815. Lindenb. Nova Acta Acad. Caes. Leop.-Car. Nat. Cur. **18**: 466. *pl. 29.* 1836.

Riccia minima L. *p.p.* Sp. Pl. 1139. 1753.

Riccia aggregata Underw. Bot. Gaz. **19**: 275. 1894.

Thallus at first subradiate, later commonly forming irregularly confluent masses, dark green, somewhat polished and closely reticulate above, dark purple or nearly black beneath, with transverse, semicircular, blackish-purple, nitent scales, which do not exceed the margin; principal divisions 2–8 mm. long, at first simple and obovate, finally linear or linear-obcuneate and 1–3 times dichotomous; terminal lobes 1–1.5 mm. wide, obcuneate-oblong or ellip-

tical-obovate, obtuse or subacute, narrowly canaliculate, the margins often brownish, acute, entire, slightly membranous, becoming rather obtuse toward the base, often erect-connivent on drying; width of transverse sections 1–2.5 (mostly 1.5–2) times their height, their ventral boundary nearly rectilinear, slightly convex toward the apex, the air-chambers narrow and inconspicuous; epidermis of a single layer of cells, these lightly protuberant, subquadrate in vertical section and often broader than high, 25–40μ × 25–45 μ, filled with a transparent and colorless or slightly grumous, somewhat refringent fluid, collapsed and disintegrated only in the oldest parts of the thallus: monoicous: antheridial ostioles but slightly or not at all elevated: capsules often numerous, crowded together near the bases of the segments, hemispherical-protuberant above together with the naked, usually light brown, long intact covering, this commonly with a small purple spot about the exserted archegonium-neck; spores brown, becoming darker and more opaque with age but usually translucent in glycerine, 60–78 μ in maximum diameter, angular, with a minutely granular or nearly smooth, sometimes interrupted margin 3–6 μ in width, the outer face with irregularly anastomose-reticulate ridges, lightly papillose or almost smooth in profile, the inner faces usually finely and somewhat regularly reticulate, with thick-walled meshes.

EXSICC. Hep. Bor.-Am. 140b.
Hep. Am. 165.

In rather dry exposed places, especially about rocks, often accompanied by *Riccia trichocarpa* and *R. minima.*

San Francisco: near the Ocean House (Bolander); hills above the Mission Dolores (Howe); Wildcat Cañon, near Berkeley (Howe), Fruit Vale (Miss Byxbee); Mitchell's Cañon, Mt. Diablo (Howe); Pasadena (McClatchie); Twin Oaks, San Diego Co. (F. W. Koch).

The Pasadena plant (*R. aggregata* Underw.) differs from the European and from the specimens of the San Francisco region in the more regularly and finely reticulate outer face of the spore, but this character shows considerable variability even in the Pasadena specimen and hardly justifies, we think, a specific separation.

The dorsal epidermis in *R. nigrella* is very different from that of any other *Riccia* we have examined. Its cells are for a long time turgid with a nearly transparent fluid which takes an intense violet stain when sections of the thallus are treated for several hours with solutions of haematoxylin. We found especially fa-

vorable for this purpose Heidenhain's iron-haematoxylin method (Zeit. f. wiss. Mik. 9: 204. 1892. Lee, Microtomist's Vade-Mecum, 175. 1896 [4th ed.]). The only European specimen of *R. nigrella* (Husnot, Hep. Gall. 96) which we have subjected to this treatment shows the same peculiarity even in the soaked-out dried material. *R. Campbelliana*, especially in forms with numerous oil-bodies, occasionally exhibits something which seems similar at first sight, but in this the epidermal cells which take the haematoxylin stain occur irregularly, are filled with a more granular substance, and appear to be simply cells with oil-bodies like those found elsewhere in the thallus.

Herr Stephani, who, we are informed, has had the opportunity of examining the original specimen of *Riccia aggregata* Underwood describes* it as dioicous; we, however, on making microtome sections of the same type material, find it clearly *monoicous*. Herr Stephani describes the "frons" of *R. nigrella* as "*subtriplo latior quam crassa*"† while that of *R. aggregata* is "*vix duplo latior quam alta*," but on comparing sections of French and Italian specimens of *R. nigrella* with sections from corresponding regions in *R. aggregata*, we find the differences slight and, we believe, of no specific significance. The length of the frond, the number of times its forking is repeated, and the form of the terminal lobes are variable characters in both the Californian and the European specimens, and, either separately or combined, afford no reliable grounds for specific distinctions.

9. RICCIA CATALINAE. Underw. Bot. Gaz. **19**: 275. 1894.

Thallus at first stellate or radiate, often forming later somewhat irregularly intertangled masses, rather loosely attached to the substratum, light green, concolorous below and furnished with a few hyaline very rudimentary scales, the younger parts extremely thin and exhibiting suggestions of a wide-meshed areolation as if from interior air-chambers, the cells of the dorsal surface large, thin-walled, and indistinctly defined (at least in soaked-out herbarium material), the older parts of the thallus spongiose-alveolate from the bursting through of the air-chambers to the upper surface, root-hairs nearly or wholly smooth within; the

* Bull. Herb Boiss. **6**: 342. 1898.

† *l. c.* 334.

principal divisions obcuneate-oblong when young, becoming linear, 3–5 times dichotomous, 6–15 mm. × 1–2.5 mm., lightly concave above, with thin, naked, slightly ascending or plane margins; the terminal segments commonly emarginate: monoicous: ostiolar papillae cylindrical, .06–.15 mm. high: capsules in a single or irregularly double series, rather prominent, the covering long intact; spores brown, darkening and rather opaque with age, 90–108 μ in maximum diameter, distinctly angular, with a granulate-crenulate or minutely tuberculate margin 4–10 μ in width, the prominent ridges of the outer face rather irregularly anastomosing, the areolae of the middle of the face, when well defined, usually very large (20–45 μ in diameter) and often enclosing an isolated tubercle or a free-ending spur, the inner faces mostly with tubercles and short free irregular ridges, sometimes with imperfect areolae.

On wet soil in the bottom of a deep cañon, Santa Catalina Island, A. J. McClatchie, Sept. 15, 1893, no. 441.

Riccia Catalinae is a near ally of *R. crystallina* L. from which it differs in the larger size, in the finally 3–5 times dichotomous more elongated divisions, which are less closely adnate to the soil, in the larger spores (60–90 μ in the various European specimens of *R. crystallina* examined), in the much less regular areolation of the spore-faces, and in the considerably larger size of the central meshes of the outer face, when these are well-formed.

The thallus is so thin and so largely occupied by air-chambers that we have been unable, from the dried material, to obtain any satisfactory sections.

PLATE 91, FIGS. 16–20. RICCA CATALINAE.

16. Portion of thallus, dry, natural size.

17. End of young terminal lobe, dorsal surface, showing position of the internal lamellae which bound the air-chambers, × 23. From a soaked-out fragment.

18. Dorsal view of thallus in the older parts, × 23.

19. Spores, × 305.

10. RICCIA CRYSTALLINA L. Sp. Pl. 1138. 1753.

Thallus in closely attached orbicular or suborbicular rosettes 5–15 mm. in diameter, light green on both sides or often tinged with yellow, spongiose with age and vesiculose-alveolate; the principal divisions mostly lobate-obcordate or obcuneate, or sometimes becoming broadly linear and 1–3 times furcate, the segments often close and somewhat crowded, terminal lobes 1.5–2.5 mm. wide, transverse sections 2.5–4 times broader than high, margins naked, subobtuse, slightly elevated on drying or nearly plane, ventral scales wanting;

air-chambers large, epidermis (in dried material) disorganized and indistinct: monoicous: ostiolar elevations prominent, cylindrical, .15–.27 mm. × .05–.07 mm.: capsules rather deeply immersed, scarcely prominent even at maturity; spores soon dark-brown, becoming nearly opaque, 60–90 μ in maximum diameter, distinctly angular, with a narrow, granulate-papillate, sometimes almost deficient, margin (mostly 3–5 μ broad), the convex face with strong anastomose-reticulate ridges, about 7 or 8 imperfectly formed areolae measuring its diameter, those near the middle usually larger (15–30 μ) and sometimes enclosing a free-ending spur, the plane faces marked with short free or irregularly anastomosing ridges, the mature more opaque spores appearing tuberculate-papillate.

On the banks of a stream upon a rocky hillside, southern slope of the Dixey Mts., Lassen Co. (M. S. Baker and F. P. Nutting, July 2, 1894). We refer here also a specimen in herb. Underwood, collected near San Francisco by Mrs. Katharine Brandegee in 1892, which, in the more solid—less conspicuously vesiculose-alveolate—thallus, approaches the closely allied *R. Brandegei* (from the southern extremity of the peninsula of Lower California).

The Lassen County plant seems scarcely to differ from European specimens of *R. crystallina* unless possibly in the greater opacity of the spores when fully mature and in their somewhat narrower margin.

Riccia crystallina is listed in Dr. Bolander's "Catalogue of the Plants growing in the Vicinity of San Francisco."

RICCIA FROSTII Aust. (Bull. Torr. Bot. Club, 6: 17. 1875), originally described from Nevada and Colorado, and since found to be quite widely distributed in the Rocky Mountain region and to extend as far eastward as the Mississippi Valley is to be expected in California. It can readily be distinguished from any of the Californian species here described by the small narrowly margined spores, 45–58 μ in maximum diameter, marked almost uniformly over the entire surface by numerous short, delicate, wavy ridges which rarely anastomose; the thallus, which is thin in texture, with a fibrous-reticulate and minutely foveolate surface, becoming lacunose and spongy in the older parts, forms flat, dark- or grayish-green rosettes, 8–15 mm. in diameter, closely adherent to the soil, with numerous narrow usually crowded divisions .5–1.5 mm. wide; the covering of the abundant

capsules is soon ruptured, exposing the spores. *R. Frostii* is dioicous, the male plant (*R. Watsoni* Aust.) being smaller and more or less purple in color, the slenderly cylindrical ostioles elevated about .1 mm.

RICCIA FLUITANS L. Sp. Pl. 1139. 1753.

Thallus thin, green, floating or immersed, often forming intertangled mats, destitute of rhizoids, or becoming terrestrial and attached by root-hairs, repeatedly dichotomous, the segments narrowly linear (.5–1.5 mm. wide, the entire thallus 1–5 cm. long), the median axis thickened, the mostly flat margins only 2- or 3-stratose, air-chambers large, oblique, usually elongated, communicating with the dorsal surface by small pores surrounded by slightly modified epidermal cells: capsules (found only in the terrestrial or semiterrestrial conditions) protuberant below with the enclosing tissues of the thallus, the spores usually set free ventrally, these yellowish-brown, translucent, 70–75 μ in maximum diameter, with a margin 3–6 μ broad, the outer face with rather smooth meshes 12–15 μ in width, inner faces less distinctly areolate.

This species was collected by Messrs. Coville and Funston in Vegas Valley, Lincoln Co., Nevada (Death Valley Expedition, no. 400) and probably occurs within the limits of California.

RICCIOCARPUS Corda; Opiz, Beitr. 1: 651. 1829.*

Plants lemna-like, floating or finally attached to the soil by the subsidence of the water, dark green, sometimes purple-margined, dichotomous, mostly 2–4-lobed, with a very pronounced median furrow, the lobes obcordate or obovate, the ventral surface bearing numerous long, pendant, linear or linear-lanceolate, reddish-violet, dentate scales; colorless ventral layer of thallus much reduced, the chlorophyll-bearing layer composed of large irregularly polyhedral chambers separated by mostly unistratose lamellae; epidermis with small but distinct stomata. Dioicous. Antheridia in an elongated ridge-like androecium situated in the median furrow. Capsule immersed.

The only recognized species is

RICCIOCARPUS NATANS (L.) Corda, *l. c.*

Riccia natans L. Syst. Nat. 1339. 1759 [Ed. 10].

Plants about 1 cm. long, the lobes 4–9 mm. wide: spores 45–55 μ, papillate-areolate, dark-brown at maturity, the areolae becoming obscure and the papillae more prominent.

Rarely found with capsules. This species has not yet been collected, so far as is known, within the limits of the state, but it is found in Oregon and is likely to occur in California.

* It would appear from a statement of M. Auguste LeJolis (Mém. Soc. nation. Sci. nat. et math. Cherbourg, 29: 167. 1894) that a separate of Corda's "Genera Hepaticarum" was published in 1828—in advance of its appearance in Opiz' Beiträge zur Naturgeschichte.

Family II. MARCHANTIACEAE.

Chlorophyll-bearing layer of the thallus (exc. in *Dumortiera*) with well-developed air-chambers, these in most cases containing a loose somewhat filamentous assimilative tissue or soon divided into smaller secondary chambers by chlorophyll-containing lamellae. Stomata (exc. in *Dumortiera*) always present, simple (*i. e.*, the pore surrounded by four or more somewhat modified epidermal cells, all in a single stratum) or dolioform (*i. e.*, the pore surrounded by a barrel-shaped wall, several cells in height, which projects into the underlying air-chamber). Sexual organs nearly always aggregated, often borne on long-stalked, capituliform receptacles.

Capsule short-stalked, breaking through the calyptra at maturity, dehiscing irregularly or by a special lid, rarely valvate. Spores always accompanied by sterile cells, which (exc. in the *Corsinioideae**) are developed as elaters.

Key to the Genera of the Marchantiaceae.

Sporogonium single, underneath the apical margin of the thallus, enclosed by an involucre consisting of two rigid, brown or dark purple valves which, previous to the maturity of the capsules, are united in a vertical keel-like suture. 2. *Targionia.*

Sporogonia in groups on stalked receptacles.

Stomata dolioform; antheridia on a disk-shaped receptacle; ♀ receptacles (in our species) with 8–11 finger-like, usually decurved rays; gemmae in dorsal, cup-shaped, dentate-margined receptacles. 10. *Marchantia.*

Stomata of the thallus simple

Always gemmiferous, the gemmae in dorsal, crescentic, entire-margined receptacles. Found in or about greenhouses. 9. *Lunularia.*

Never with gemmae-cups.

Thallus large (5–25 cm. × .75–1.5 cm.) areolae very distinct, the elevated stomata easily visible without magnification. The uppermost cells of the thin, sharp'y defined, chlorophyll-bearing layer each with a conical or long-cylindrical colorless beak. 8. *Conocephalum.*

Thallus smaller (less than 5 cm. long in the Californian species), cells of the chlorophyll-bearing stratum never with a colorless beak.

Sporogonia each surrounded by a membranous, white or sometimes violet pseudoperianth, this at first somewhat conical, usually much exserted, finally more or less completely divided longitudinally into 3–18 narrow segments. 7. *Asterella.*

Pseudoperianths wanting or very rudimentary.

♀ branch arising from the dorsal surface of thallus, the peduncle without a root-hair furrow; stomata normally stellate (*i. e.*, the cells bounding the pore have the radial walls strongly thickened). 3. *Clevea.*

* This subfamily is not represented in North America, so far as is now known.

♀ branch arising from apex of thallus or thallus-lobe, the peduncle with a single root-hair furrow,* stomata not stellate.

Thallus thin; air-chambers large and empty, separated by mostly unistratose lamellae; antheridia immersed in the thallus in an elongated, single or irregularly double median row just back of the peduncle, ostioles inconspicuous; ♀ receptacle finally disciform. 6. *Cryptomitrium.*

Thallus somewhat firm and rigid, the primary air-chambers soon filled by secondary walls; ♀ receptacle hemispherical or subconical.

Capsule at maturity completely filling the broadly campanulate involucre and protruding. 5. *Grimaldia.*

Involucre conchoid-bivalved, its cavity only partially filled by the capsule. 4. *Reboulia.*

2. TARGIONIA L. Sp. Pl. 1136. 1753. Ex Mich. Nov. Pl. Gen. 3. *pl.* 3. 1729.

Thallus usually rather thick and coriaceous, simple or once or twice dichotomous, innovating at apex or often latero-ventrally, broadly costate, areolae mostly indistinct, stomata simple, the white-margined pores more or less conspicuous; chlorophyll-bearing layer sharply defined, the chambers filled with branched "conferva-like" filaments, epidermal cells thick, their walls with trigones; ventral scales reaching to margin or much reduced. Gemmae none. Androecium small, disciform, terminating a short latero-ventral shoot. Archegonia in a group of several arising just back of the apex of the thallus, becoming apparently ventral by the over-arching of the surrounding dorsal tissues, without a special receptacle, a single archegonium of the group ordinarily maturing a sporogonium, this soon surrounded by a somewhat laterally compressed, obovoid, subglobose, or hemispherical 2-valved involucre, the anterior margins of the latter uniting to form a median vertical keel-like suture, finally gaping widely and exposing the capsule, the valves rigid, entire-margined, brown or dark purple, at times iridescent. Pseudoperianth none. Sporogonium consisting of a subglobose capsule, a very short pedicel, and a bulbous foot; capsule dehiscing irregularly, its wall of a single layer of cells with annular or spiral thickenings. Spores opaque, nearly spherical, the outer membrane thrown into ridges and wart-like folds, loosely investing the firmer inner coat and occasionally caducous, the entire surface minutely and irregularly reticulate or granulate. Elaters 2–4-spiral, often branched.

* See footnotes on following pages under generic diagnoses of *Reboulia* and *Grimaldia* and also remarks upon *Cryptomitrium* in Erythea, 5: 87. 1897.

1. TARGIONIA HYPOPHYLLA L. *l. c.*

Thallus mostly simple, sometimes dichotomous, obovate to sublinear, commonly linear-obcuneate, progressing chiefly by latero-ventral or apical innovations, 4–20 mm. long, 2–5 mm. in maximum width, rounded or slightly emarginate at apex, reddish-brown or dark-purple beneath, the margins usually involute or erect-connivent on drying, colorless stratum of about 25 layers of cells in axile parts, rather suddenly reduced to the ventral epidermis toward the lateral margins; scales densely imbricate, the superior extending to the margin, often abruptly contracted to a narrow, sometimes twisted, subentire or ciliate-dentate apical appendage: monoicous: spores brown, 58–80 μ; elaters 180–330 μ $\times$ 6–12 μ, subacute or obtuse.

Exsicc. Hep. Bor.-Am. 137 (as *Targionia Michelii* Corda). Hep. Am. 159.

On shaded banks, mostly in rocky soil. Common, particularly in the Coast Range Mountains from San Diego to Humboldt County, and extending northward to Vancouver Island (Macoun). Berkeley; San Francisco; Sausalito, Mill Valley; Sonoma (F. T. Bioletti), Duncan's Mills; Ukiah (746) and Big River Boom (681), Mendocino Co.; Blue Lake (997), Humboldt Co.; Oak Run, Shasta Co. (Baker and Nutting); Jackson, Amador Co. (George Hansen); Ojai, Santa Barbara Co. (W. F. Hubby) Nordhoff, Ventura Co. (Miss Jacqueline K. Newton); Pasadena (A. J. McClatchie); San Bernardino (S. B. Parish); San Diego (W. G. Farlow) and Twin Oaks (F. W. Koch), San Diego Co.; Surprise Cañon, Inyo Co. (Coville and Funston, Death Valley Expedition, no. 619); also, by the last named collectors, in Lincoln Co., Nevada. First found in California by Dr. Bolander.

3. CLEVEA Lindb. Not. ur Sällsk. pro Fauna et Flora Fenn. 9: 289. 1868.

Thallus usually small, simple or once dichotomous, sometimes innovating from the apex, distinctly areolate, the areolae but slightly elevate-pulvinate, the cells bounding the stomata with (typically) strongly thickened radial walls; air-chamber layer of numerous empty cavities with mostly unistratose dissepiments, these cavities appearing in several series in the median portions in a cross section, occupying the greater part of the axial thickness of the thallus and composing the whole of the wings, being gradu-

ally or rather abruptly reduced to a single series toward the thin thallus-margins ; postical scales numerous, hyaline, at least at their apices, or rarely purple throughout, obtuse, acute or long-acuminate, the anterior usually exceeding the margin of the thallus and often conspicuous. Dioicous. Antheridia immersed, scattered near the median line of the thallus, with slender subcylindrical ostiolar papillae. ♀ branch from the median dorsal surface of the thallus, commonly arising at a considerable distance back of the apex, single or in a linear series of 1–4. Peduncle subpellucid, without a root-hair furrow. ♀ receptacle consisting simply of the 4 (–1) obovoid somewhat downwardly inclined involucres, these lightly compressed laterally and bilabiate about to the middle by a vertical cleft, affixed directly to the top of the peduncle or slightly connate at the bases. Pseudoperianth none ; capsule nearly sessile and included or subexserted by a somewhat elongate pedicel, its walls on dehiscence cleft to the middle or below into 3–8 irregular valves, the cells with numerous annular or spiral thickenings. Spores yellowish, red, or brown, densely covered with rather large obtusely conical papillae. Elaters 2–4-spiral.

1. CLEVEA HYALINA (Sommerf.) Lindb. Not. ur Sällsk. pro Fauna et Flora Fenn. **9** : 291. 1868.

Marchantia hyalina Sommerf. Mag. Naturv. II. **1** : 284. 1833 (*fide* Lindberg).

Plagiochasma erythrosperma Sulliv.; Aust. Proc. Acad. Nat. Sci. Philad. 1869 : 229. 1869.

Thallus strongly concave or canaliculate above, narrowly oblong to obovate, obcordate at the apex, simple or once forked, 5–15 mm. long, 2–6 mm. in greatest width, scales mostly numerous and persistent, conspicuously projecting, with rare exceptions, and the anterior often inflexed, hyaline, sometimes purple at base, rarely purple throughout, acute or acuminate, the occasionally subtubulose points with crenulate margins: peduncle usually single, 2–15 mm. high ; ♀ receptacle 2.5–4 mm. broad, with long and numerous white or purplish paleae beneath : capsule dehiscing by 3–6 irregular valves, the wall-cells with annular thickenings ; spores 44–60 μ, reddish-brown, rarely verging toward yellow or darkening ; elaters 120–300 μ long, 8–15 μ in greatest width, often bispiral at the extremities, in the middle mostly tri-, rarely quadri-spiral.

About rocks in mountainous regions, especially northward. "Near a lake on the trail to the White Chief Mine, 1100 ft. above Mineral King, Tulare Co." (Coville and Funston, Death Valley

Expedition, Aug. 6, 1891, no. 1511); also, by the same collectors, "near White Chief Mine" (no. 1528).

1b. **Clevea hyalina Californica** var. nov.

*Santeria limbata** Aust. *p. p.* Proc. Acad. Nat. Sci. Philad. 1869: 229. 1869.

Thallus often once dichotomous, with strongly pronounced radial ridges or undulations on the ventral surface toward the thin margin, very distinctly areolate, pores in the median parts large and elliptical, often 50–150 μ in length, the radial walls of the bounding cells unthickened, the pores near the margin smaller, with the radial walls of the surrounding cells more or less clearly incrassate, scales purple or slightly decolorate at their extremities, exceeding the margin: peduncle delicate, slender, 25–32 mm. high, with few and rather inconspicuous paleae at the apex; involucres for the most part strongly discrete: capsule finally subexserted, the pedicel attaining a length of 2 mm.

Doolan's Creek Cañon, near Ukiah, May 13, 1896 (Howe, no. 765); a specimen collected by A. J. McClatchie on the trail to Wilson's Peak, San Gabriel Mts., April, 1893, has more in common with this variety than with the typical form, though the peduncles are shorter, the capsules sometimes subsessile, the areolation is less distinct, and the guard-cells of the stomata have more strongly thickened radial walls. Professor McClatchie's plant differs, too, from both the Ukiah specimen and the typical *C. hyalina* in the very slender inconspicuous scales with almost filiform points.

The Ukiah plant is a remarkable one, and it is with misgivings that we refer it to *Clevea hyalina* as a mere variety, but the Wilson's Peak specimen, though somewhat aberrant in scale-characters, bridges over the gap in respect to the stomata and in some other particulars, as noted above. The form possibly needs comparison with *Clevea pedicellata* (*Plagiochasma pedicellatus* Griff. Not. ad Pl. Asiat. 2: 331. *pl. 68. f. 2.* 1849) from Afghanistan, though the latter would appear from figure and description to differ at least in 8- or 9- instead of 4- or 5-valved capsule.

Mr. Austin, who published "*Plagiochasma erythrosperma*" from a plant thus labeled (with, however, a query-mark after the "n. sp."),

* For remarks on the use of the name *limbata*, see footnote under *Asterella Californica*.

in the Sullivant collection, was apparently the first to recognize that the name was a synonym for *Clevea hyalina*, as is attested by a pencil inscription in Austin's handwriting on the pocket containing the original specimen, now in the herbarium of Harvard University. The several plants since collected in the mountainous regions of the western United States and British America, and identified with this species of Sullivant's, though quite variable, cannot, we think, be satisfactorily distinguished from the *Clevea hyalina* of Europe. The spores, however, often incline more to red, and the thallus is sometimes proportionally broader.

Of true *Sauteria*, we have seen the following three American specimens, probably all referable to *Sauteria alpina* (Nees & Bisch.) Nees: "under rocks, Sulphur Mts., Banff, J. Macoun, 16 July, 1891, no. 345;" "under rocks, Lake Agnes, 7000 ft., J. Macoun, 19 Aug., 1891, no. 364"; St. Paul Islands, Pribiloff Group, Behring Sea, 1897 (Mr. Trevor Kincaid).

4. REBOULIA Raddi (as *Rebouillia*) Opusc. scientif. di Bologna, 2: 357. 1818.*

Asterella Pal. de Beauv. *p. p.* Encyc. Meth. Bot. Suppl. 1: 502. 1810.

Thallus coriaceous and rigid, dichotomous, usually, also, innovating at the apex, broadly costate, scale-bearing and dark-purple or brownish beneath, the dorsal surface without evident areolation, provided with small scattered simple stomata, epidermal cells with trigones: chlorophyll-bearing layer strongly developed, passing gradually into the colorless stratum, the latter limited to the region of the costa, cells with oil-bodies occurring here and there in both, air-chambers at first simple, their limits afterwards obscured by more or less numerous secondary walls; root-hairs numerous, colorless. Gemmae none. Androecium sessile or somewhat sunken, in the median line of the thallus, disciform, suborbicular or with a lunate sinus in front, often surrounded by a few narrow scales. ♀ receptacle conical or hemispherical, becoming at times nearly plane above, paleaceous-barbate beneath, containing air-chambers and furnished with dolioform stomata, cleft about to the middle into 1–6 (commonly 4 or 5) thick, often spreading lobes, the membranous ventral margins of these forming the conchoid-bivalved involucres, each of the latter enclosing a single sporo-

* This citation is as given by authors We have been unable to see the original paper.

gonium. Pseudoperianth wanting. Peduncle from the apex of the thallus-lobe, with a single root-hair furrow, * destitute of assimilative tissue, surrounded at the base by a few narrow, whitish or purple paleae, the receptacle conspicuously involucrate when young and sessile. Sporogonium consisting of a subglobose capsule, a scarcely perceptible pedicel, and a large foot. Capsule only partially filling the involucral cavity, yellowish-green, the apical portion of its wall falling away in fragments at dehiscence, leaving behind a subhemispherical urn with an erose-dentate margin, the cells without annular or spiral fibers, those in the apical region with trigones or sometimes exhibiting irregular nodulose thickenings in the lateral walls. Spores yellow or brownish, more or less distinctly tetrahedral, all the faces with rather large often irregular areolae, the angles pellucid-margined, membrane finely granulate. Elaters 2–4- (mostly 3-) spiral.

1. REBOULIA HEMISPHAERICA (L.) Raddi, *l. c.*

Marchantia hemisphaerica L. Sp. Pl. 1138. 1753.

Asterella hemisphaerica Pal. de Beauv. Encyc. Meth. Bot. Suppl. 1: 502. 1810.

Thallus 6–30 mm. long, rather pale green above, the segments emarginate at apex, obcuneate or obcordate, less commonly elongated, margins undulate-crenulate: monoicous: peduncle mostly 1.5–3 cm. in length, rarely longer: spores 65–80 μ; elaters 300–450 μ long, 10–12 μ in maximum width, the apices subobtuse.

A cosmopolitan species, but the only Californian station we can cite is Folsom (Katharine Brandegee).

5. GRIMALDIA† Raddi, Opusc. scientif. di Bologna, 2: 356. 1818.‡

Thallus somewhat firm and rigid, broadly costate or sometimes sharply carinate, dichotomous and often innovating at the

* Schiffner in his key to the Marchantiaceous genera in Engler & Prantl, Nat. Pflanzenfam. 1[3]: 25, denies a "Wurzelrinne" to *Reboulia*, but we find it always present, as described by Nees, Limpricht, and others, both in European and American forms of the plant.

† We are not unmindful of the fact that *Grimaldia* is said to have been used by Schrank in 1805 and 1808 as a generic name for certain species of phanerogams, which by later writers have been almost universally referred to *Cassia* or to *Chamaecrista* (Breyne, 1678; Moench, 1794). There can, therefore, be no doubt that a literal carrying out of Article IV. of the Rochester Code would call for the disappearance of *Grimaldia* from among the names of genera of Hepaticae, and indeed from all botanical literature save the strictly historical, unless, perchance, some one should find grounds for recognizing again the *Grimaldia* of Schrank as a genus. But until some one actually proposes to revive the older *Grimaldia*—if that time ever comes—it seems to us to be conducive to clearness to retain in use the only "*Grimaldia*" that has been generally known to botanists for the past eighty years.

‡ See footnote under *Reboulia*.

apex or latero-ventrally, mostly dark purple beneath, dorsal surface very indistinctly areolate, furnished with simple inconspicuous stomata, epidermis thick, the walls of its cells more or less thickened at the angles, chlorophyll-bearing layer deep, passing gradually into the colorless stratum, somewhat inflated cells with oil-bodies often occurring in both, the primary air-chambers soon filled by secondary walls: scales extending to the margin or projecting and inflexed at the thallus-apex, purple or vinous-red, sometimes conspicuously hyaline-pointed or nearly colorless throughout. Gemmae none. Monoicous, dioicous, or polyoicous. Antheridia immersed near the median line of the thallus, sometimes at about the middle of a segment, but mostly forming a papillate androecium near an apical sinus, the androecium surrounded by the slightly elevated adjacent tissues or wholly destitute of a special involucre, covered occasionally by the inflexed thallus-margins. ♀ receptacle with a single archegonium in each of the 3 or 4 short lobes, maturing 1–4 sporogonia, finally long-stalked, hemispherical-umbonate or subconoidal, commonly papillate above, the lobes at maturity mostly directed downward, rarely somewhat spreading, often obscurely defined. Peduncle from apex of the thallus or from a small latero-ventral innovation, with a single root-hair canal,* more or less paleaceous-involucrate at base, clothed underneath the receptacle with pendant, often white, paleae, these sometimes obsolete or wholly wanting. Involucres broadly campanulate, continuous with the lobes, the margins repand. Pseudoperianth none or rudiamentary. Capsule globose, completely filling the involucres and protruding, circumscissile above the middle, cells of its wall destitute of annular thickenings or with traces of such at the margin of the thicker operculum, pedicel very short. Spores yellow, brown or dark violet-purple, tuberculate, rugose, or sometimes rather regularly areolate. Elaters 2–4-spiral, often somewhat attenuate toward the extremities.

1. GRIMALDIA CALIFORNICA Gottsche; Underw. Bot. Gaz. **13**: 114. 1888. Bolander, Cal. Med. Gaz. 1870: 184 (40) (name only). 1870.

Grimaldia Californica Steph. Bull. Herb. Boiss. **6**: 794. 1898. Thallus linear or spatulate-oblong, 6–20 mm. × 1.5–4 mm.,

* The peduncle of *Grimaldia* is said by Schiffner in his key to the genera of the Marchantiaceae to be without a "Wurzelrinne" (Engler & Prantl, Nat. Pflanzenfam. 1³: 25), but it is surely present in *G. Californica*, *G. pilosa*, *G. androgyna* (*Marchantia androgyna* L. *pro parte maxima*, *Grimaldia dichotoma* Raddi) and in American specimens of *Grimaldia fragrans*; it seems, however, to be sometimes only rudimentary in European specimens of *G. fragrans*, though attributed to the species without reservation by Nees and by Limpricht.

dichotomous, or progressing by latero-ventral, very rarely apical innovations, broadly costate, 25–30 cells thick in median parts, mostly crescentic in cross section with broad, thin, often erect or inflexed, commonly purplish margins, the air-chambers almost wholly filled by secondary walls, leaving very small lacunae; ventral scales purple, closely imbricate, the inferior reniform or obliquely ovate, subentire or irregularly dentate, extending to the margin, the superior ovate or lanceolate, rather abruptly narrowed to a slender, acuminate, often bifid, subnodose or repand point, slightly exceeding the margin and inconspicuously inflexed at the apical sinus, their tips rarely decolorate: polyoicous: antheridia immersed, with short-papilliform ostiola, somewhat scattered near the middle of a thallus-segment or aggregated near the apex, without special involucre, the androecium when subapical often more or less covered by the inflexed thallus-margins: peduncle from the apex of a small obovate or cordate latero-ventral innovation, 1.5–2.5 cm. high, mainly reddish, pale above, with a few small purple scales at base, naked beneath the receptacle or obsoletely palaceous; ♀ receptacle small, 1.5–2.25 mm. in maximum width, hemispherical-conoidal, lightly papillate above, obscurely lobed, maturing 1–4 sporogonia: capsule purplish; spores dark violet-purple, 55–75 μ, obscurely angular, tuberculate-verrucose especially on the outer face, the often loose and saccate exterior membrane of the inner faces commonly rugose or irregularly areolate, entire surface minutely papillate or granulate; elaters 2–4- (mostly 3-) spiral, purple both as to the bands and the unthickened wall, often considerably attenuate at one or both extremities, 200–300 μ long, 9–15 μ in greatest width.

Yosemite Valley, "on rocks in the spray of Bridal Veil Fall, June, 1866" (Bolander); also in the region of the Yosemite Valley by C. M. Cooke, Jr., 1896 (in herb. A. W. Evans); on trail to Wilson's Peak, San Gabriel Mts. (A. J. McClatchie, Apr. 21, 1893).

A portion of Bolander's original, communicated by Dr. Gottsche to Professor Underwood, is in the Underwood Herbarium. Other specimens from the first collection are in the herbaria of Professor Underwood, of Columbia University, and of the U. S. National Museum.

Grimaldia Californica is somewhat nearly allied to *Grimaldia androgyna* (L.) Lindb. of Southern Europe, but clearly differs in the purple elaters, the dark purple spores, the broader thallus with thinner margins, the rather smaller, more conoidal, less evidently

lobed ♀ receptacles, in the origin of the peduncle from a small latero-ventral innovation, which seems to occur rarely in *G. androgyna*, and in other characters of less moment.

PLATE 92. GRIMALDIA CALIFORNICA.

1. Plant, natural size.
2. Thallus, with androecia and vegetative latero-ventral innovations, × 3.
3. Thallus, with androecia and peduncle-bearing innovation, × 3.
4. Thallus, with peduncle-bearing innovations, × 3.
5. ♂ thallus, × 3.
6. Transverse section of thallus, × 12.
7. Transverse section of thallus through androecium, × 12.
8. Transverse sections of mature peduncles, × 29.
9.–13. Outlines of ventral scales, mostly from near thallus apex, × 29.
14. Stoma and adjacent epidermal cells, × 305.
15–17. ♀ receptacles (containing dehisced capsules), × 4.
18. Ventral view of receptacle with dehisced capsules, × 8.
19. Spores, × 305.
20. Elater, × 305.

All figures drawn from soaked out dried specimens; 1–4, 6, 8, 9, 11, and 14–20, from portions of the original material collected by Dr. Bolander and preserved in herb. Underwood (partly communicated by Dr. Gottsche and partly from U. S. National Herbarium); 5, 7, 10, 12, and 13, from specimen collected by Professor A. J. McClatchie in the San Gabriel Mts.

6. CRYPTOMITRIUM Aust.; Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 36. 1884.

Platycoaspis Lindb. Kongl. Sv. Vet. Akad. Handl. **23**[5]: 11. 1889.

Thallus thin, green and often somewhat polished above, concolorous or purple beneath, 6–15 mm. long, 1–3 times irregularly dichotomous, with the inner margins of the terminal segments now and then connate, sometimes progressing by apical or lateral innovations from the rather thick costa, the segments obovate, obcordate, or oblong, 3–9 mm. in maximum width, venulose-areolate, stomata simple, the minute pores surrounded by several finally oblong cells with unthickened radial walls; scales small, violet-purple, irregularly biseriate, broadly ovate, variously lobed, extending half way to the margin or fragmentary and inconspicuous; air-chamber layer of large empty cavities separated by mostly unistratose lamellae, these chambers in 3–5 layers over the costa in transverse section, occupying the whole of the very thin alar expansion and reduced to a single layer at the margin, the latter green or brownish-purple, undulate-repand or crenate, slightly as-

cending when dry, furnished with a unistratose border 1–3 cells in width; costa (exclusive of air-chamber layer) 15–20 cells in thickness, gradually attenuate to the wing on either side. Monoicous. Antheridia immersed in the thallus just posterior to the base o the ♀ branch, in a single or irregularly double, often much elongated, row, each completely filling the loculus at maturity and adnate to its walls, ostioles papilliform, inconspicuous. ♀ branch from the apex of the costa. Peduncle slender, naked throughout, pale or sometimes brownish-purple below, irregularly sulcate, the dorsal (posterior) face without assimilative tissue, the ventral (anterior) face with a single root-hair furrow.* ♀ receptacle subhemispherical in early stages, soon becoming circular-disciform, lightly convex and somewhat papulose above, plane and naked beneath, much attenuated toward the crenate margin, furnished with 3–7 (commonly 5) radiating root-hair canals in communication with the root-hair furrow of the peduncle, these reaching a little more than halfway to the margin, surrounded by a compact tissue, and, after drying, sometimes appearing costa-like; air-chambers large, in a single layer, with dolioform stomata; archegonia in groups of four, alternating with the root-hair canals, one archegonium of each group (very rarely two) producing a sporogonium. Sporogonia (3–7, usually 5) occupying ellipsoidal radiately disposed loculi reaching commonly a little more than half the distance to the periphery of the receptacle, the margins of the loculus early connivent and enclosing the capsule, separating later by an elongated radial cleft, this finally gaping and widely exposing the capsule, the lips becoming membranous-scarious, remaining somewhat elevated, and functioning as the only involucre. Calyptra inconspicuous. Capsule nearly spherical or oblately ellipsoidal, the apical third or fourth of its wall consisting of two layers of cells and falling away as an operculum in dehiscence, the wall otherwise unistratose, the cells without annular or spiral thickenings, those of the operculum with the walls slightly thickened at the angles. Seta very short, foot bulbous. Spores brown, more or less distinctly tetrahedral, irregularly areolate-lamellate, with a pellucid margin. Elaters attenuate, contorted, often branched, closely 2-(3-) spiral.

The only recognized species is

* Herr Stephani (Bot. Gaz. 17: 58. 1892) has described the peduncle of Californian specimens of *Cryptomitrium* as bicanaliculate. In his latest paper on the subject (Bull. Herb. Boiss. 7: 222. 1899) he reports that in Chilian plants he finds the peduncle with one or with two root-hair furrows in one and the same specimen. In our investigations upon Californian material and the Hookerian type, we have as yet been unable to find any peduncle with more than one furrow containing root-hairs.

1. CRYPTOMITRIUM TENERUM (Hook.) Aust. l. c. Stephani, Bot. Gaz. **17**: 58. 1892. Bull. Herb. Boiss. **7**: 222. 1899. Howe, Erythea, **5**: 87. *pl. 3*. 1897.

Marchantia tenera Hook.; Kunth, Syn. Pl. **1**: 46. 1822.

Duvalia tenera Gottsche; G. L. & N. Syn. Hep. 554. 1846.

Peduncle 15–30 mm. × .3—.5 mm.: spores 35–50 μ; elaters 300–450 μ long, 7–11 μ in greatest width.

On moist shaded banks. Fruit Vale, Alameda Co. (Miss Edith S. Byxbee, Howe); Navarro, Mendocino Co. (*fide* Miss Byxbee); Menlo Park (Blasdale); Folsom (Mrs. Brandegee); Jackson, Amador Co. (Hansen); San Bernardino (Parish, no. 2221); Pasadena (McClatchie). Also collected in California by Parry, Bigelow, Bolander, and Torrey (*fide* Austin).

The original plant of Hooker was collected near Ario [State of Michoacan (?)] Mexico, by Humboldt. A portion of this, bearing the legend "no. 236, *Marchantia tenera*, n. sp.," Legit "Humboldt," has been sent to Professor Underwood through the kindness of Dr. W. T. Thiselton-Dyer, the Director of the Royal Botanic Gardens at Kew, and is deposited in the herbarium of Columbia University. This fragment, rather unfortunately, bears only very young capsules, so we have been unable to compare spores and elaters, but it seems to agree essentially with the Californian plant in structure of thallus and peduncle, form of ♂ receptacle, position of antheridia, etc. The peduncles are, however, much shorter, being only 3 or 4 mm. high, but this may be due, in part, to the immaturity of the receptacle; they are, moreover, only about half as thick as in the Californian specimens, which may, perhaps, be partly accounted for by the possibility that after so many years' drying they may not fully regain their natural size on soaking out.

Duvalia brevipedunculata Mont. from Chili (*legit* Gay) is thought by authors to be the same species. The Californian plant is, however, in need of further comparison with those of Mexico and Chili.

PLATES 93 AND 94.

CRYPTOMITRIUM TENERUM.

1–4. Principal segments of thallus, natural size; fig. 2, with a fully developed ♀ receptacle and peduncle.

5. Ventral view of a thallus-segment, × 3.

6. Thallus-lobe showing young ♀ receptacle and position of antheridia, × 3.

7. Margin of thallus-lobe, dorsal view, showing position of the internal lamellae which mark the boundaries of the air-chambers, × 23 (from alcoholic material).

8. Outline of median longitudinal section of thallus with antheridia and young ♀ receptacle, × 23.

9. Portion of a transverse section of a thallus-lobe, passing through androecium × 23.

10. Median region of a transverse section (about 10 μ in thickness), passing through androecium, × 41.

11. Marginal region of the same transverse section, × 41.

12. Anterior margin of thallus-lobe from a slightly oblique longitudinal section, × 225.

13 and 14. Outlines of cross-sections of mature peduncles, × 53 (dried material).

15. Outlines of cross-sections of a peduncle from the original material of "*Marchantia tenera*" collected in Mexico by Humboldt, × 53.

16. Section of young peduncle, × 50.

17. Stoma, surface view, × 225.

18. Transverse section of thallus-apex with young ♀ receptacle, × 23.

19. Vertical section through ♀ receptacle with mature sporogonium (slightly schema'ized), × 23.

20. Vertical section of a young ♀ receptacle about half way between the vertical axis and periphery, traversing one of the "costae" with its root-hair canal, × 23.

21. A thin horizontal section of a young ♀ receptacle, showing the archegonia in cross-section in groups alternating with the root-hair canals, × 38.

22. A young antheridium, free in its loculus, × 225.

23. A mature antheridium, with wall more or less blended with that of the loculus, × 53.

24–27. Receptacles with mature sporogonia, × 4; 24 and 25, lateral views, the former from alcoholic, the latter from dry material; 26 and 27, dorsal views, the latter from a pressed specimen and showing externally the position of the "costae"; 28, ventral view.

29. Capsule, apical view, showing operculum, × 23.

30 and 31. Vertical sections of capsules-wall, showing the bistratose operculum, × 27.

32. Spore, outer face, × 305.

33. Elater, × 305.

Figs. 1–3, 6–12, 16–24, 26, 28–31, from material collected at Fruit Vale, Alameda County, fixed at 1% chromic acid, and preserved in alcohol; 4 from Folsom (Mrs. Brandegee); 5, dry material, Fruit Vale; 13, 14, 32 and 33, dry material, Menlo Park (Mr. W. C. Blasdale); 15, Mexico (Humboldt); 27, Pasadena (McClatchie).

7. ASTERELLA Pal. de Beauv. *p. p.* Encyc. Meth. Bot. Suppl. 1: 502. 1810.

Fimbraria Nees, Hort. Phys. Berol. 44. 1820. [Afterward amended to *Fimbriaria.*]

Hypenantron Corda; Opiz, Beitr. 1: 648. 1829.* Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 33. 1893.

Thallus simple or somewhat sparingly dichotomous, sometimes innovating in front, or laterally from near the ventral aspect of the more or less distinctly defined costa, very thick, usually with a thin often colored margin, commonly dark purple beneath, pores and areolae of the dorsal surface distinct or somewhat obscure in drying, air chambers deep or rather small and shallow, scales mostly violet-purple, rarely white. Stomata of the thallus simple, the cells bounding the pore with unthickened radial walls; stomata of ♀ receptacle dolioform. Monoicous or less commonly dioicous. Antheridia in slightly elevated or indistinctly defined receptacles borne in the median line of the thallus or on short specialized lateral branches. ♀ receptacle obtusely conical or subhemispherical, sometimes depressed-umbonate or flattened with age, maturing 1–6 (usually 3 or 4) sporogonia, these enclosed singly in the strongly or obscurely defined lobes. Peduncle a direct continuation of the thallus or of a thallus-lobe, the latter sometimes a small innovation springing from one side of the median ventral line of the costa, the dorsal (posterior) face of the peduncle without assimilative tissue, the ventral (anterior) face with a single root-hair furrow, in communication with which at the apex are root-hair sinuses in the receptacle alternating with its lobes. Sporogonium and the commonly inconspicuous calyptra surrounded by a special membranous involucre, the pseudoperianth, this at first somewhat conical, becoming usually much exserted, finally with 3–18 longitudinal clefts, the narrow segments coherent at the apex or soon becoming free. Capsule globose, ovoid, or obovoid, more or less regularly circumscissile above the middle or (in *A. Californica*) the apical third or half of the wall falling away irregularly in dehiscence, leaving a fimbriate-lacerate margin, the wall—for the most part, at least—of a single layer of cells, without annular or spiral thickenings, but often exhibiting distinct trigones, especially in the apical portion. Seta very short, foot bulbous. Spores rather large, yellow, brown, fuscous, or black, obscurely tetrahedral or flattened, usually with a pellucid margin, areolate-reticulate, verrucose, or irregularly rugose. Elaters 1–4-spiral.

Key to the Species.

♀ branch from apex of thallus or of one of its main segments.

♀ receptacle strongly lobed, paleaceous-barbate beneath; segments of pseudoperianth coherent at apex; spores yellow, elaters mostly unispiral; dioicous. 1. *A. Californica.*

♀ receptacle conic-ovate, scarcely lobed, naked beneath; segments of pseudoperianth coherent at apex; spores fuscous or black, elaters 1–3-spiral; monoicous. 4. *A. Palmeri.*

* See foot-note under *Ricciocarpus*, p. 33.

♀ receptacle subhemispherical, obscurely lobed, naked beneath; segments of pseudoperianth soon free; spores yellow or light brown, elaters 2–4-spiral; monoicous. 5. *A. gracilis.*

♀ branch from apex of a small lateral innovation, the latter springing from the costa at one side of its median ventral line.

♀ receptacle subhemispherical or depressed-umbonate, 2–3.5 mm. in maximum width; pseudoperianth white, 10–12-cleft; spores 65–85 μ, elaters 8–10 μ broad. 2. *A. Boanderi*

♀ receptacle subconoidal, 2.5–5 mm. in maximum width; pseudoperianth commonly violet, 12–18-cleft; spores 60–125 μ, elaters 9–16 μ broad. 3. *A. violacea.*

1. ASTERELLA CALIFORNICA (Hampe) Underw. Bot. Gaz. **20**: 60. 1895.

Fimbriaria Californica Hampe; Aust. Hep. Bor.-Am. 135. 1873. Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 41. 1884.

Sauteria limbata * Aust. *p.p.* Proc. Acad. Nat. Sci. Philad. 1869: 229. 1869.

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* Through the kindness of Professor F. E. Weiss of the Owens College, Manchester, England, we have enjoyed the privilege of being able to examine the original material upon which the *Sauteria limbata* of Austin was founded. We find, as does Count Solms-Laubach, who has also studied the type specimen (See Bull. Herb. Boiss. **6**: 773. 1898), that Mr. Austin's diagnosis was drawn from two entirely distinct species, but we would differ from Count Solms as to the identity of the plant from which the first and greater part of Mr. Austin's description was made and from which the character embodied in the specific name was derived. This we find to be the ♂ thallus of the always dioicous *Asterella Californica.* We were assisted to this view by the discovery of an androecium, which apparently escaped the notice both of Mr. Austin and Count Solms. The antheridia were found to be united in a definitely circumscribed and slightly elevated area and to have short ostiolar papillae instead of being scattered and having slenderly subcylindrical ostiolar papillae as in *Sauteria* and *Clevea.* The ventral scales, stomata, dorsal epidermis, and internal structure were then compared with the corresponding parts of *Asterella Californica* and were found to agree so accurately as to remove all doubts of the specific identity of the two plants. And we could discover no evidence of admixture save with the fertile plant from which Mr. Austin drew the description of the ♀ receptacle and peduncle of his *Santeria limbata.* This fertile plant we refer to our *Clevea hyalina Californica.* Count Solms, however (*fide* Stephani, *l. c.*) found the stomata of the "sterile" plant to conform to those of *Clevea hyalina.* We, on the other hand, found that the radial walls of the cells bounding the stomata were sometimes slightly thickened, but no more so than in *Asterella Californica* and never in any such way as in the typical stomata of the *Astroporae. Asterella Californica* was found growing at Ukiah in rather close association with our *Clevea hyalina Californica.*

Count Solms, in his MS. notes left with the type-material, retains the specific name *limbata* for the "sterile" [♂] plant, and it would seem to us that the name should be maintained for this plant if for either, inasmuch as the description of it occupies the first and by far the greater part of the original diagnosis and inasmuch as it was

Clevea limbata Solms *p.p.*; Stephani, Bull. Herb. Boiss. **6**: 773. 1898.

Thallus 8–25 mm. long, usually 1–3 times dichotomous, rarely simple, the ultimate segments emarginate, obovate, obcordate, or broadly oblong, indistinctly areolate, 4–12 mm. in maximum width, abruptly carinate, lightly concave above, sometimes narrowly canaliculate toward apex, 25–35 cells thick in axile parts, with rather large air-cavities, margins undulate-crenate, commonly broad, thin, and brownish-purple, ascending on drying, or occasionally erect and connivent, the reddish-purple scales subovate or ovate-lanceolate, not reaching to the margin or sometimes inconspicuously projecting and inflexed toward the apex, each with 1–4 slenderly acuminate or subfiliform, nearly entire, often decolorate, apical processes: dioicous: ♂ and ♀ plants mostly in separate patches; antheridia in clearly circumscribed, slightly elevated, strongly papillate, oval to linear-oblong, sometimes forked discs, situated in the median line of the thallus at some distance back of the apex: ♀ receptacle from the apex of the thallus, bearing 2 or 3 archegonia in each of the 4 or 5 groups, maturing 1–5 (commonly 4) sporogonia, large (4–7 mm. in maximum width), finally subhemispherical, convex-umbonate, nearly smooth above, containing large air-chambers and becoming vesicular-rugose in drying, paleaceous-barbate beneath, with strongly defined, rather turgid, often spreading, entire or crenate-margined lobes; peduncles stramineous, stout, 10–30 mm. × .5–.6 mm., naked or very sparingly pilose, without paleae at base, sulcate, angled, and slightly twisted when dry; pseudoperianth white, large, ovate, 12–16 cleft, the segments co-

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evidently the "broad, wavy, dark purple, membranaceous margin of the frond" of this that suggested the name. Others, however, might contend that the name should go with the more complete capsule-bearing plant. If retained for the former (the *Asterella*), it would appear to have four years priority over the name *Californica*, and would thus, in accordance with the Rochester Code, replace this latter name But the determination of sterile and even of antheridiiferous thalli of the Marchanticeae is sometimes a difficult and delicate matter, and it is to be feared that in this particular case the identity of the scanty material upon which "*Sauteria limbata*" was chiefly founded might always be more or less of a "bone of contention." The unsatisfactoriness of this material may be seen from the fact that while we identify it without hesitation with *Asterella Californica*, a botanist of the experience and high standing of Count Solms-Laubach refers it without reserve to the genus *Clevea*. Under these circumstances it seems to us the wiser course to leave aside altogether the name *limbata*

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Since the above note was written, Count Solms-Laubach, to whom we had sent a specimen of *Asterella Californica* for comparison, admits (Bot. Zeit 57[1]: 30. 16 F. 1899) that we have shown "ziemlich zweifellos" its identity with the sterile portion of the original "*Sauteria limbata*" material

hering at the rather obtuse apex, their margins plane or lightly reflexed; capsule prolate-ellipsoidal or subglobose, the apical third or half of its wall falling away irregularly in dehiscence leaving behind a cup with a fimbriate-lacerate margin; seta very short; spores yellow, 90–135 μ, obscurely tetrahedral, furnished when mature, especially at the angles and on the outer face, with conspicuous irregular ridges or wings, the entire surface minutely reticulate (meshes 1–5 μ); elaters 150–240 μ × 12–18 μ, obtuse, slightly flexuous, with one or, more rarely, two, yellow spiral bands.

Exsicc. Hep. Bor.-Am 135 (as *Fimbriaria Californica*).
Hep. Am. 119 (as *Fimbriaria Californica*).

On open or lightly shaded banks, often about rocks, from San Diego as far north, at least, as Mendocino and Shasta counties. Berkeley; San Leandro (Underwood); San Francisco (Bolander, Brandegee, Howe); Mill Valley; Duncan's Mills, Sonoma Co.; Ukiah and Half-Way House, Mendocino Co.; Oak Run, Shasta Co. (Baker & Nutting); Jackson, Amador Co. (Geo. Hansen); Murphy's, Calaveras Co. (J. Burtt Davy); Mt. Diablo, Contra Costa Co.; Knight's Landing, Stainslaus Co. (F. W. Bancroft); Fresno (F. P. Nutting); Kaweah River, Tulare Co. (Coville); Lake San Andreas, San Mateo Co.; Palo Alto (Campbell); Santa Cruz (Farlow); Santa Barbara (Farlow); Nordhoff, Ventura Co. (Miss Jacqueline K. Newton); Santa Monica (Dr. Hasse); Pasadena (Underwood, McClatchie, Miss Teed); Santa Ana Hills (Parish, no. 1728); Twin Oaks, San Diego Co. (F. W. Koch), San Diego (Farlow). First collected by Bolander and by Bigelow.

Somewhat resembling in size and habit *Asterella Lindenbergiana* Lindb. (*Fimbriaria Lindenbergiana* Corda), but very distinct in being dioicous, in the broader, obovate thallus-segments, in the more strongly lobed receptacle, the white pseudoperianth, the much larger, more prominently rugose-winged, more minutely reticulate, yellow spores, the yellow spiral band of the elaters, the irregular dehiscence of the capsule, etc.

PLATES 95 AND 96. ASTERELLA CALIFORNICA.

1. ♀ plant, natural size, with fully developed receptacle and peduncle.
2 and 3. Male plants, natural size.
4. A large sterile thallus, natural size.
5. ♀ plant with young receptacles, natural size.

6. Ventral view of thallus, natural size.

7. Outline of transverse section of ♂ thallus, near apex, × 23.

8. Outline of transverse section through androecium, × 23.

9. Outline of longitudinal section through androecium, × 12.

10. A very thin median longitudinal section of thallus, × 48.

11–13. Ventral scales, × 12.

14. Cross-section of young peduncle, × 41.

15. Cross-section of a mature peduncle, × 23.

16. Surface view of stoma from near thallus-apex, × 305.

17. Outline of portion of longitudinal section of thallus passing through a young receptacle, × 23.

18. Section of ♀ receptacle in a plane perpendicular to the peduncle, showing two archegonia in transverse section in each lobe, one of each group fertilized and surrounded by the developing pseudoperianth, × 23.

19–21. ♀ receptacles, the first young, the others with matured sporogonia, × 4.

22. Sectional view of a dolioform stoma from ♀ receptacle, × 225.

23. Outline of mature sporogonium, × 12.

24. Capsule after dehiscence, × 12.

25. Spore, outer face, × 225. (The folds and ridges of the epispore become sometimes more numerous than here represented.)

26. Spore, inner faces, × 225.

27. A portion of the wing-margin of spore, showing the minute reticulation, × 305.

28. Sections of fully matured spores, showing the great development of the episporic layer, × 225. The section on the left passes considerably to one side of the center of the spore and consequently gives a somewhat exaggerated idea of the thickness of epispore in comparison with the width of the lumen.

29. Elaters, × 225.

Figs. 11–13 drawn from material collected by Mr. J. Burtt Davy in Calaveras County; 25–27, and 29, from Oak Run, Shasta County (M. S. Baker and F. P. Nutting); the remaining from specimens collected by the author in Mill Valley and near Berkeley.

2. ASTERELLA BOLANDERI (Aust.) Underw. Bot. Gaz. **20**: 61. 1895.

Fimbriaria Bolanderi Aust. Proc. Acad. Nat. Sci. Philad. 1869: 230. 1869.

Aromatic: thallus oblong to narrowly linear, 10–45 mm. × 1.5–4 mm., costate-carinate, 25–35 cells thick in the middle, becoming very thin at the usually desiccated border, innovating in front or laterally from the costa, very rarely dichotomous, indistinctly porose, scarcely areolate, light green above, usually purple below, rounded or very slightly emarginate at the apex, nearly flat or lightly concave when living, the membranous, undulate-crenate, brown or purple margins often erect and appressed-connivent on drying, air-cavities small, scales dark purple, not reaching the margin, the costa densely clothed with matted root-

hairs: monoicous: androecia and ♀ branches on short lateral innovations, the latter 1.5–3 mm. in length, springing from the sides of the costa, those bearing a ♀ branch expanded, emarginate, bilobed, or somewhat obcordate, 1–3 mm. in maximum width, those bearing the androecia subclavate, only slightly expanded at the distal extremity, .75–1 mm. in greatest width, all furnished beneath with scales and root-hairs: ♂ receptacles with 4–10 antheridia, lightly papillate: ♀ receptacle with a single archegonium in each of the 4 lobes, maturing, commonly, 3 or 4 sporogonia, subhemispherical at first, becoming subconical, depressed-umbonate, or muc hflattened, with lobes somewhat divergent, 2–3.5 mm. in maximum width, containing small air-chambers, rugose on drying, surrounded and more or less covered, when young and sessile, with narrow paleae, these springing mostly from its ventral surface or from the top of the peduncle, inconspicuous at maturity; peduncle slender, 10–25 mm. × .25–.55 mm., brownish-purple below, pale above, sparingly pilose toward the base, apex of the innovation often with a few inflexed scales; pseudoperianth white, conical and acute when young, finally subglobose, with 10–12 widely gaping clefts, the segments cohering at the apex, rarely free with age, mostly with revolute margins: capsule subglobose, sometimes oblately flattened, nearly black at first, becoming brown, circumscissile somewhat above the middle, the margin irregularly toothed; spores obscurely tetrahedral, 65–85 μ, yellowish-brown, becoming darker, alveolate-areolate, with 4–6 areolae across each face, the angles of the spore with a yellow pellucid margin; elaters 200–250 μ × 8–10 μ, closely 2-(3-) spiral.

Exsicc. Hep. Bor.-Am. 136d (as *Fimbriaria Bolanderi*).
Hep. Am. 158 (as *Fimbriaria Bolanderi*).

On lightly shaded banks. Fruit Vale, Alameda Co. (Miss Edith S. Byxbee); Mill Valley, Marin Co. (Howe); Hood's Peak, Sonoma Co. (F. T. Bioletti); Howell Mountain, Napa Co. (W. A. Setchell); Jackson, Amador Co. (Geo. Hansen); Twin Oaks, San Diego Co. (F. W. Koch). The species was originally collected at San Rafael by Dr. Bolander in 1865; it was also found by Dr. Bolander in the same year in dry ditches near the American River at Auburn.

The lateral innovations in this species show a tendency to group in such a way that nearly all on one side of the thallus bear antheridial discs and nearly all on the other side ♀ branches. In the San Diego County specimen the elaters are sometimes unispiral.

PLATE 97. ASTERELLA BOLANDERI.

1. Plant, natural size.
2. A sterile thallus, natural size, somewhat unusually elongated.
3. Thallus, branching by latero-ventral innovations, × 3.
4. Thallus with the small ♂ and ♀ latero ventral innovations and an apical vegetative innovation, × 3.
5. Receptacle with mature sporogonia, × 4 (from alcoholic material).
6. Young receptacle × 4 (alcoholic).
7. Mature receptacle (dry), × 4.
8. Mature receptacle (dry), × 8.
9. Longitudinal section of thallus a little one side of the median line, showing insertion of the ♂ and ♀ innovations, × 23.
10. Median longitudinal section of the thallus, × 47.
11. Transverse section of the thallus, with androecium, × 23.
12. Innovation with young ♀ receptacle, × 8.
13. Innovation bearing androceium, × 8.
14. Stoma, surface view, × 225.
15. Longitudinal section of innovation with young ♀ receptacle, × 23.
16. Portion of transverse section of thallus with longitudinal section of a ♂ branch, × 41.
17. Transverse section of one of the innovations near the base, × 41.
18. Cross-section of peduncle, × 41.
19. Sporogonium, × 12.
20. Capsule after dehiscence, × 12.
21. Spores, × 225.
22. Elater, × 225.

The figures are drawn, for the most part, from specimens collected in Mill Valley, Marin County.

3. ASTERELLA VIOLACEA (Aust.) Underw. Bot. Gaz. **20**: 61. 1895.
Fimbriaria violacea Aust. Bull. Torr. Bot. Club, **3**: 17. 1872.

Aromatic: thallus oblong to narrowly linear, 8–25 mm. × 1.5–5 mm., broadly costate-carinate, 30–40 cells thick in median parts, becoming very thin at the border, innovating in front, or more often, laterally, from the costa, sometimes dichotomous, obscurely areolate, indistinctly porose, rounded or slightly emarginate at the apex, densely radiculose along the costa, concave or canaliculate above when moist, the usually broad brownish membranous undulate-crenate margins commonly erect and appressed-connivent on drying, air-chambers small, scales dark purple, sometimes reaching the margin: monoicous: androecia and ♀ branches borne on short innovations, the latter springing from the sides of the costa near the median ventral line, 1.5–4 mm. long, those bearing a ♀ branch bilobed, obcordate, or emarginate-subquadrate, 2–4 mm. in maximum width, those bearing an androecium clavate, slightly expanded at apex, .75–1 mm. in maximum

width: androecia with 6–12 antheridia, lightly papillate: ♀ receptacle enclosing a single archegonium in each of the four lobes, maturing 2–4 (usually 3) sporogonia, subconoidal with lobes directed downward or only slightly spreading, very rarely becoming depressed-umbonate, 2.5–5 mm. in maximum width, containing small air-chambers, nearly smooth, or, on drying, subrugose, densely surrounded when young and sessile by narrow paleae springing from its ventral surface or from the upper part of the peduncle, these usually persistent and conspicuous at maturity; peduncle 10–40 mm. × .35–.55 mm., brownish-purple, becoming abruptly pale near the receptacle, pilose toward the base; pseudoperianth commonly violet, conical, finally obovoid-subpyriform, or subglobose, with 12–18 narrow or somewhat gaping clefts, the segments cohering at the apex or often becoming free with age, sometimes flexuous and contorted, the margins commonly revolute: capsule nearly spherical, the apical third or half of its wall falling away in dehiscence in irregular fragments, leaving a subhemispherical cup with an erose-dentate margin; spores yellow, becoming brownish, 60–125 μ, alveolate-areolate, with 4–7 areolae across each face, the pellucid margins finally broad; elaters 180–320 μ × 9–16 μ, closely 2- or 3-spiral, the bands yellow or slightly brown.

On exposed or somewhat shaded banks. Olema, Marin Co. (Jepson); St. Helena, Napa Co. (Jepson); Ukiah, Mendocino Co. (Howe); Oak Run, Shasta Co. (Baker and Nutting); Jackson, Amador Co. (Hansen); Pasadena (McClatchie, Feb. 18, 1893—mixed with *A. Palmeri*). Collected also by Coulter and by Bolander, the precise locality unknown. Not known to occur outside of California.

Asterella violacea seems occasionally to approach *A. Bolanderi*, but is usually very distinct in the violet 12–18-cleft pseudoperianth, the larger more conical ♀ receptacle with less spreading lobes and more abundantly paleaceous-barbate beneath, and in the commonly larger spores and broader elaters. The violet coloration sometimes disappears from the pseudoperianth, but in such cases a trace of purple is often to be detected on the outer involucre near its margin.

PLATE 98. ASTERELLA VIOLACEA.

1. Plant, natural size.
2. Thallus, showing branching and the ♂ and ♀ innovations, × 3.
3. Thallus, natural size, with the somewhat unusual dichotomous branching.

4–6. ♀ receptacles with matured sporogonia, × 4.

7–8. Transverse sections of thallus, showing in the latter a ♂ innovation, × 23.

9. Transverse section of peduncle, × 41.

10. Capsule in dehiscence, × 12.

11. Capsule after dehiscence, × 12.

12. Elater, × 225.

13. Spore, outer face, × 225. (The walls of the areolae appear somewhat too rigid.)

Figures all from soaked-out dried material; 1–3, 5, and 7–9 from specimens collected by Mr. Geo. Hansen near Jackson, Amador Co.; 4, St. Helena (Mr. W. L. Jepson), 6, Olema, Marin Co. (Jepson).

4. ASTERELLA PALMERI (Aust.) Underw. Bot. Gaz. **20**: 63. 1895.

Fimbriaria Palmeri Aust. Bull. Torr. Bot. Club, **6**: 47. 1875. Steph. Bull. Herb. Boiss. **7**: 213. 1899.

Fimbriaria nudata M. A. Howe, Erythea, **1**: 112. 1893. Steph. Bull. Herb. Boiss. **7**: 212. 1899.

Asterella nudata Underw. Bot. Gaz. **20**: 61. 1895.

Thallus simple or once dichotomous, 5–10 mm. long, 2–5 mm. in maximum width, the segments or entire thallus obcordate to obcuneate, rather indistinctly areolate above, dark purple beneath, broadly carinate, 30–40 cells thick in median parts, with numerous and deep air-chambers, the brown or purple, usually broad, undulate-crenate margins ascending, commonly appressed-connivent on drying, scales dark purple, very rarely decolorate, often extending slightly beyond the margin, a few sometimes inconspicuously inflexed at the apical sinus: monoicous: antheridia occupying a lightly elevated oval or oblong, papillate area just posterior to the base of the ♀ branch: receptacle maturing 2–6 (commonly 3 or 4) sporogonia, becoming obtusely conic-ovoid, scarcely lobed, sometimes constricted near the middle in drying, 2.5–4 mm. in maximum width, nearly smooth or subrugose when dry, naked beneath, air-chambers large; peduncle from apex of the thallus, light brown or stramineous, 12–40 mm. (mostly 15–20 mm.) × .35–.65 mm., naked, without involucre at base, sulcate, rather brittle; pseudoperianth white, the exserted portion globose-ovoid, often strongly constricted at zone of emergence, with 8–12 narrow or somewhat gaping clefts, the segments coherent at the apex: capsule nearly spherical, irregularly circumscissile above the middle; spores 60–80 μ, at first almost colorless, marked only with faint ridges or lines, at maturity very opaque, fuscous or black, with a rather narrow warty border, the faces irregularly rugose-areolate; elaters 1–3-(mostly 2-) spiral, 120–270 μ × 10–18 μ, sometimes branched, finally yellowish-brown.

Mill Valley (Howe), St. Helena (Jepson), Jackson (Hansen), Pasadena (McClatchie), San Bernardino (Parish), Santa Monica (Hasse); also at San Diego by an unknown collector and at Witch Creek, (San Diego Co. ?) (R. D. Alderson).

The original specimens were collected by Dr. Palmer on Guadalupe Island, off the coast of Lower California. Portions of what appear to be the original plants are found in herb. Underwood and herb. Columbia University.

Asterella fragrans (Schleich.) Trevis.—to which *A. Palmeri* is probably most nearly allied—has been found in New Mexico, Idaho and Alaska, and is likely to occur in California. This differs from *Asterella Palmeri* in the conspicuous white scales projecting beyond the margin of the thallus, in the presence of an involucre of narrow whitish paleae at the base of the peduncle, in the yellow, more broadly margined spores, etc. The spores of *Asterella Palmeri* show a tendency to cohere in large masses until very late in the process of ripening—a character which seems also to be exhibited by *A. fragrans*.

PLATE 99.

1-15. *Asterella Palmeri*.

1. Plant, natural size.

2. Thallus, showing peduncle and position of androecium, × 3.

3. Transverse section of thallus through androecium, × 23.

4. Median longitudinal section of thallus, passing through androecium and base of peduncle, × 23.

5 and 6. Fully developed ♀ receptacles, dry, × 4.

7-10. Series of cross-sections of peduncle fom near apex to base, × 41.

11. Capsule in dehiscence, × 12.

12. Elater, × 225.

13. Young spore, × 225.

14. Mature spore, × 225.

15. Section of mature spore, × 225.

Figs. 1, 2, 6, 12 and 13 drawn from Guadalupe Island material (legit Palmer); 3-5, 7-10 and 15, St. Helena (Jepson); 11 and 14, Jackson, Amador Co. (Hansen).

5. ASTERELLA GRACILIS (Web. *f.*) Underw. Bot. Gaz. **20**: 61. 1895.

Marchantia gracilis Web. *f.* Hist. Musc. Hep. Prod. 105. 1815.

Marchantia pilosa Wahl. Fl. Lapp. 399. 1812. Not *M. pilosa* Horn. Fl. Dan. 8: 7. *pl. 1426.* 1810.

Marchantia Ludwigii Schwaegr. (?) Hist. Musc. Hep. Prod. 33. 1814.

Fimbriaria gracilis Lindb. Not. ur Sällsk. pro Fauna et Flora Fenn. 9: 282. 1868.

Thallus simple or once dichotomous, linear-obcuneate, sometimes oblong or obovate, 4–10 mm. × 1.5–3 mm., rather distinctly porose and areolate, canaliculate or somewhat broadly concave, dark purple underneath, 25–35 cells thick in median parts, with deep air-chambers, the narrow, purple or concolorous, undulate-crenate margins ascending, or, on drying, sometimes erect and connivent, scales purple, reaching the margin or now and then projecting a little beyond: monoicous: antheridia few, immersed in the thallus just posterior to the base of the ♀ branch, loculi with papilliform ostioles: ♀ receptacles maturing 1–4 (mostly 3) sporogonia, subhemispherical, 1.5–3 mm. in diameter, nearly smooth, becoming rugose in drying, naked beneath, the obscurely defined lobes with a thin membranous border; peduncle from the apex of the thallus, 10–40 mm. × .3–.5 mm., light brown to brownish-purple, naked, surrounded at the base by a few, often inconspicuous scales or paleae; pseudoperianth white, 5–12- (mostly 8-) cleft, the segments early becoming free, most frequently somewhat inclined together, sometimes spreading: capsule quite regularly circumscissile above the middle; spores yellow or slightly brown, 48–64 μ, narrowly margined, areolate-reticulate or with shallow alveolae, the meshes 5–8 across each face, with somewhat thickened walls and angles; elaters 150–275 μ × 7–15 μ, 2–4-spiral, more or less attenuate at the ends, commonly flexuous or contorted, sometimes branched.

Near Mineral King, Tulare Co. (Coville and Funston, Death Valley Expedition, nos. 1420 and 1510, August 1891).

8. CONOCEPHALUM* Wigg. Prim. Fl. Hols. 82. 1780.

Fegatella Raddi, Opusc. scientif. di Bologna, 2: 356. 1818.†

Thallus large, dichotomously branched, with long root-hairs springing in tufts from the narrow clearly defined costa, areolae very distinct, mostly hexagonal, stomata simple (except on ♂ and ♀ receptacles), large, forming whitish pustule-like elevations, the pores easily visible to the unaided eye; chlorophyll-bearing

* We have been unable to verify this citation. A transcription of Wiggers' diagnosis is given by M. Auguste Le Jolis (Mém. Soc. nation. Sci. nat. et math. Cherbourg 29: 125. 1894).

† See footnote under *Reboulia*.

stratum thin, the uppermost cells in the air-chambers with a conical or long-cylindrical colorless rostrum; costa clothed with closely imbricate scales, those at the apex often with a violet orbicular or reniform apical expansion, marginal scales absent. Gemmae-cups wanting. Androecium disciform, strongly papillate, sessile in a depression bounded by a somewhat scarious-membranous elevation of the dorsal layers of the thallus, terminating a short branch, this becoming apparently lateral by the continued growth of the other fork. ♀ receptacle obtusely conical, indistinctly or not at all lobed, long-stalked, surrounded when still sessile by a slightly elevated membranous sheath; peduncle with a single root-hair furrow, its dorsal (posterior) surface destitute of assimilative tissue. Involucres 4–11, tubular, confluent, constituting almost the whole of the matured receptacle, each surrounding a single sporogonium. Pseudoperianth wanting. Capsule oblong-pyriform, on a thick pedicel mostly a little more than one half as long, dehiscing by cleavage about to the middle into 4–8 recurved irregular valves, its final exsertion usually accompanied by the detachment of the pedicel from the receptacle, capsule-wall of mainly a single layer of thick cells with annular and spiral thickenings; spores large, papillate, multicellular at time of dehiscence; elaters rather short and thick, 2–4-spiral.

1. CONOCEPHALUM CONICUM (L.) Dumort. [as *Conocephalus*] Comm. Bot. 115. 1822. Underw. Bot. Gaz. **20**: 67. 1895.

Marchantia conica L. Sp. Pl. 1138. 1753.

Fegatella conica Corda; Opiz, Beitr. **1**: 649. 1829.*

Thallus oblong or linear, 5–25 cm. × .75–1.5 cm.; colorless stratum in region of the costa of 20–25 layers of small thick-angled cells, enclosing 3–5 large longitudinal (finally empty) mucilage canals and passing abruptly at the sides into 7–4 layers of larger cells, becoming bi- (rarely uni-) stratose at the extreme margin: dioicous: peduncle 3–6 cm. high, naked: spores yellowish-brown, 66–95 μ; elaters 200–270 × 9–30 μ, often dilated in the middle.

In moist deeply shaded places, especially on stones and rocks beside streams.

Felton, Santa Cruz Co. (Underwood); on stones in stream-bed near Lake Pilarcitos, San Mateo Co.; on moist ground in woods, "Big River Boom," near Mendocino; and on shaded dripping rocks near Eureka. Not common in California; first collected by Professor Underwood in 1888.

* See footnote under *Ricciocarpus*, p. 33.

None of the Californian specimens seen bear ♀ receptacles. The measurements of spores and elaters have been taken from a plant collected near Seattle, Washington, by C. V. Piper.

Conocephalum in a sterile state may be readily distinguished from *Marchantia polymorpha* by the usually longer thallus, the very distinct mostly hexagonal areolae, the simple (not "compound" or "dolioform") stomata with pores easily visible to the unaided eye, the conical or elongate-cylindrical rostrum of the upper green cells in the air-chambers, the absence of marginal scales, the narrow clearly defined costa, etc.

9. LUNULARIA Adans. Fam. Pl. 15. 1763. Ex Mich. Nov. Pl. Gen. 4. *pl.* 4. 1729.

Thallus moderately large, furcate or often progressing by innovations from the apex, with an effuse median thickening, the segments oblong or obcuneate, with a hyaline unistratose margin 1–4 cells in width, areolae mostly indistinct after drying; stomata simple, the pores invisible to the unaided eye, the surrounding elevated cells, however, often whitish and readily visible; chlorophyll-bearing stratum narrow in a sectional view, occasional cells of the colorless layer containing a large oil-body in the form of an emulsion. Gemmae in crescentic receptacles, the thin entire margin of the latter wanting in front. Dioicous (sometimes monoicous?). Androecium sessile, oval-disciform, papillate, surrounded by a slight elevation of the adjacent parts. ♀ receptacle arising from a deep sinus of the thallus, surrounded when young and sessile by a tubular-ovate sheath, consisting of numerous scales, the inner of these membranous, hyaline, ciliate-fimbriate; archegonia in commonly four groups of three or four, only one in each group developing a sporogonium; receptacle destitute of stomata and root-hairs, consisting at maturity almost wholly of the slightly thickened top of the peduncle and of the 1–6 (usually 4) spreading tubular involucres each surrounding a single sporogonium. Pseudoperianth wanting. Peduncle without a root-hair furrow, delicate, pellucid, pilose, involucrate at base. Capsule dark-brown, obovoid, rather long-stalked, exserted from the bilabiate or repand-mouthed involucre, quadrivalved to the base in dehiscence, the valves often 2-parted, more or less twisted in drying, the cells of the wall without annular or spiral thickenings. Spores yellow or brownish, smooth. Elaters bispiral, very long and slender, often adhering a long time to the ends of the valves.

Only one species of the genus is ordinarily recognized:

1. LUNULARIA CRUCIATA (L.) Dumort. Comm. Bot. 116. 1822.

Marchantia cruciata L. Sp. Pl. 1137. 1753.

Thallus 1–5 cm. × .5–1 cm., colorless layer about 20 cells thick along the axis, becoming gradually thinner to the unistratose margin : peduncle 1.5–3 cm. high : spores 15–18 μ ; elaters 300–650 μ long, 5–6 μ broad in the middle.

In and about greenhouses. Oakland, San José, and San Francisco (Underwood, 1888); Berkeley and San Francisco (Howe); also in the Golden Gate Park, San Francisco, at considerable distance from any greenhouse; Pasadena (*fide* McClatchie). Introduced from Europe. Only a sterile gemmiferous condition is known to occur in America, but the plant is easily recognizable by the crescentic, entire-margined gemmae-cups, which are almost always present. Our diagnosis has been completed from European material and from the descriptions of authors.

10. MARCHANTIA L. Sp. Pl. 1137. 1753.

Ex March. *fil.* Act. Ac. Paris. 229. 1713.*

Thallus large, usually several times dichotomous, with a broad effuse costa, the root-hairs abundant, areolae mostly rhombic, stomata dolioform throughout, often not readily visible to the unaided eye ; air-chamber stratum sharply defined against the underlying colorless tissue, of a single layer of caverns, these filled with branched, chlorophyll-bearing filaments. Gemmae in cup-shaped, dentate-margined receptacles arising from the dorsal surface of the costa. Androecium long-stalked, disciform, with a thin crenate margin or stellately or palmately lobed, furnished with scales on the ventral surface. ♀ receptacle stellate or rarely subentire, usually somewhat eccentric, with 4–11 often much elongated and finger-like, deflexed or spreading rays, each of the latter containing a single root-hair canal communicating with its ventral surface or, at distal extremity, wholly enclosed. Peduncle with two (very rarely three) root-hair furrows, provided on its dorsal (posterior) surface with stomata and an air-chamber layer.† Archegonia commonly in 8 groups of several each (sometimes in 4 groups, occasionally in other numbers by suppression, abortion,

* Citation from Pfeiffer, Nomenclator Botanicus.

† This, in effect, is asserted of the genus *Marchantia* by Stephani (Bot Gaz. 17: 60 1892. Bull. Herb. Boiss. 7: 384. 1899). Most of the numerous species of *Marchantia* are exotic and we are unable to assert from any personal investigations that this character belongs to all. It certainly holds good for *M. polymorpha*.

or irregular multiplication) alternating * with the rays, these, however, one in excess of the archegonia-groups. Each group of archegonia usually maturing several sporogonia, these enclosed by a common membranous 2-valved, fimbriate involucre, and each surrounded by a cleft pseudoperianth. Capsule borne on a seta as long as the pseudoperianth, dehiscing by several revoluble teeth or short valves. Spores small, smooth or nearly so. Elaters long and narrow, 2-(1–3-) spiral.

1. MARCHANTIA POLYMORPHA L. Sp. Pl. 1137. 1753.

Thallus prostrate or ascending, rarely suberect, often in widely extended masses, oblong or linear, 2–10 cm. × .5–2 cm., commonly several times dichotomous, about 16 cells thick in the middle of the costa, becoming gradually thinner to the narrowly unistratose, mostly somewhat undulate-crisped or irregularly short-lobed margin, areolae mainly rhombic, the pores scarcely visible to the unaided eye; the outer ventral scales oblong, obtuse, slightly exceeding the margin, colorless or tinged with brown or purple: dioicious: androecium peltate, with commonly 8 short rounded lobes or merely crenate: ♀ receptacle with 8–11 (commonly 9) finger-like, usually decurved rays; involucre fimbriate, its segments subulate-acuminate and ciliate-laciniolate, often rufous; peduncle of ♀ receptacle 2–7 cm. long, more or less pilose, that of the androecium usually shorter: capsule finally exserted, its wall unistratose, with annular thickenings; seta attaining length of 1–1.5 mm.; spores yellow, 12–15 μ, nearly smooth; elaters 300–600 μ long, attenuate, 3–5 μ in greatest width, bispiral.

On wet banks, in bogs, beside streams, about greenhouses, etc.

Widely distributed in California but hardly common. We can name only the following localities: Berkeley; San Francisco; Mill Valley, Olema; near Duncan's Mills, Sonoma Co.; Mendocino (577); near Eureka; near Douglas City (1161), Trinity Co.; Sisson; near Redding (Baker and Nutting); Silver Lake, Alpine Co. (Geo. Hansen); Jackson, Amador Co. (Geo. Hansen); San Bernardino Mts. (S. B. Parish, nos. 1445, 1446, 1693, 1694, 3369); vicinity of Pasadena (A. J. McClatchie). Also collected in California by Dr. Bolander. We have found no mature capsules in any Californian specimens and our description has been supplemented from material collected in Europe and in the eastern portions of the United States.

* Exc. *M. geminata* N. R. & Bl. See Schiffner, Ueber exotische Hepaticae, Nova Acta Ksl. Leop.-Carol. Deutsch. Akad. Naturforsch. 60: 280, 281. 1893.

Marchantia Oregonensis was described by Herr Stephani in 1891 (Bot. Centralb. **45**: 203) from ♂ plants collected by Röll on Mt. Hood. The only distinctive character emphasized is a reniform irregularly dentate and spinose appendage to the postical scales. In a portion of the original plant communicated by Herr Stephani to Professor Underwood, we have been able to detect a few such scales immediately bounding the costa at the apical sinus, but there are also oblong or linguiform, obtuse, entire scales toward the margin as in *M. polymorpha;* as we have observed quite similarly appendaged scales at the apex of the costa in European specimens of *M. polymorpha* (*e. g.*, Rab. Hep. Eur., no. 6; Massal. Hep. It. Ven. Exs., no. 21) and also in American specimens, we believe that this peculiarity has no specific significance. These appendages are usually of a violet or brownish color and are formed by a more or less pronounced narrowing of the scale accompanied by a slight twisting or convolution in the zone of contraction.

Order II. JUNGERMANNIALES.

Gametophore varying in different genera from a wholly leafless thallus, with or without a midrib but without other differentiation of tissues, to a cylindrical leaf-bearing stem. Root-hairs always with smooth walls. Stomata wanting. Sexual organs usually in groups, often on more or less modified branches, yet never on special stalked receptacles, rarely immersed.

The first division of the fertilized egg transverse, the lower of the two cells usually taking no further part in the development of the embryo.* Sporogonium provided with foot and seta, the latter commonly much elongated; calyptra ruptured. Capsule nearly always opening by four valves. Sterile cells always accompanying the spores, usually developed as elaters.†

The order Jungermanniales comprises the two somewhat artificial families, the Metzgeriaceae (see below) and the Jungermanniaceae (see page 82).

* See Campbell, The Structure and Development of the Mosses and Ferns, 72. 1895.

† Among the Californian genera, the sterile cells in *Sphaerocarpus* (which has several points of contact with the Ricciaceae) may be easily overlooked unless the contents of somewhat immature capsules are studied. The sterile cells are here starch-laden, are destitute of spiral thickenings and become disorganized or inconspicuous by the time he spores are fully ripe.

Family III. METZGERIACEAE.*

Apical cell of the gametophore never directly transformed into an archegonium. Sporogonia arising from the dorsal surface of the gametophore or only apparently from an apex. This family contains all the *Jungermanniales* in which the gametophore is persistently thallose and also the forms transitional between the thallophytic and cormophytic types. The aberrant genera *Haplomitrium* and *Calobryum* do not occur, so far as is known, on the North American continent. The involucres of the sexual organs and of the sporogonium very rarely, if ever, represent true leaves.

KEY TO THE GENERA OF METZGERIACEAE

Seta very short, less than $\frac{1}{10}$mm. long; spores accompanied by sterile cells without spiral thickenings.

♀ gametophore suborbicular, the somewhat leaf-like peripheral lobes almost entirely concealed by the numerous subglobose, cylindrical-ovoid, or fusiform-clavate involucres; annual 11. *Sphaerocarpus.*

Gametophore a somewhat elongated thickened axis, with conspicuous crowded irregularly succubous foliar expansions on either side; perennial through the conversion of a large portion of the axis into a tuber. 12. *Geothallus.*

Seta 4–50 mm. long; elaters always developed.

Gametophore with quite clearly defined stem and leaves; root-hairs very long, mostly violet or vinous-purple. 16. *Fossombronia.*

Gametophore thalloid, without ventral scales and without special gemmae-receptacles.

Thallus rather fleshy, pinnately, palmately, or subdichotomously branched, the unistratose marginal lamina, if present, narrow and passing gradually into the costa; antheridia and archegonia on short lateral branches; spores unicellular. 13. *Riccardia.*†

Thallus irregularly dichotomous, the wide unistratose margin passing gradually into the indistinct costa; antheridia in loculi on the back of the costa, archegonia in a cavity near its apex; spores multicellular at time of dehiscence. 14. *Pellia.*†

Thallus with a narrow costa sharply limited from the unistratose marginal laminae, mostly dichotomous; antheridia and archegonia on short ventral branches. *Metzgeria* (p. 75).

Gametophore thalloid, but the thin margin often with more or less leaf-like lobes; cavities near the bases of the lobes commonly occupied by *Nostoc* colonies; ventral surface bearing small dentate scales; gemmae in long-necked, flask-shaped receptacles arising from the dorsal surface near the ends of the lobes; spores unicellular. 15. *Blasia.*

* Underwood, Bot Gaz 19: 361. 1894. The "Jungermanniaceae anakrogynae" of Leitgeb and of Schiffner.

† Sterile conditions of *Riccardia pinguis* and *Pellia* sp. may be easily confused. See remarks under *R. pinguis*.

11. SPHAEROCARPUS* Adans. Fam. Pl. 2: 14. 1763. Ex Mich. Nov. Pl. Gen. 4. *pl.* 3. 1729.

Gametophore small, orbicular, oblong, or cuneate, thallus-like and irregularly lobed or now and then subfoliose, of a few layers of nearly similar cells in central or median parts, the lobes unistratose unless at base, ascending or flat; root-hairs smooth, colorless, long and numerous. Dioicous. Sexual organs in most cases numerous and thickly covering the dorsal surface of the thallus, surrounded singly, rarely in groups of 2 or 3 (*fide* Leitgeb†), by unistratose involucres. ♂ plants much smaller than the ♀, scarcely visible to the unaided eye, commonly tinged with purple, oblong or cuneate, often once dichotomous or subpalmately lobed. Antheridia oval, on very short stalks, the involucres flask-shaped or subconical. Archegonial involucres usually crowded and more or less completely concealing the thallus, from tubular or clavate to pyriform or subglobose, orifice reduced to a small apical pore, this often enlarged at maturity. Calyptra of 2 or 3 layers of cells, usually ruptured early, the upper portion, with the archegonium neck, long persisting on the apex of the capsule.

Sporogonium consisting of a nearly spherical capsule, a very short or almost obsolete seta, and a well-developed foot. Capsule indehiscent, its wall of a single layer of cells destitute of spiral, annular, or other local thickenings. Spores permanently adherent in 4's, or (*S. Donnellii* Aust.) becoming free at full maturity, or (*S. cristatus* M. A. Howe) separating early in the development of the sporogonium; tetrads, when persistent, distinctly areolate, appearing crenulate, papillate, or subechinulate in optical section; spores, when separating, compressed-tetrahedral, rounded-

* Mr. James Britten (Journal of Botany, 36: 397–399. 1898) has recently called attention to the use in 1759 and 1763 of *Sphaerocarpus* as a name for the cruciferous genus commonly known as *Neslia*. The name is said to occur in both the first and second editions of Fabricius' "Enumeratio Plantarum Horti Helmstadiensis," published at the dates mentioned, respectively. In the first edition, which alone has clear priority over Adanson's work, "*Sphaerocarpus* Heister" appears simply as a synonym of "Rapistrum arvense fo io auriculato T." It would seem that the usual interpretation of the Rochester Code [the interpretation which denies the publication of *Dalea* as a genus in the Species Plantarum of Linnaeus (1753)] must be unable to recognize the publication of *Sphaerocarpus* as a genus in the above use of the word in the first edition of Fabricius' "Enumeratio." In any event, it would be a gross violation of the spirit of the priority principle to annul the original *Sphaerocarpus* of Micheli, grandly described and figured in 1729, in order to validate the application thirty years later of the same name to a totally different genus.

†Leitgeb, Untersuchungen über die Lebermoose, 4: 67, 68. 1879.

lenticular, or sometimes concavo-convex, areolate or cristate, in *S. Donnellii* prominently tuberculate-papillate in the basilar circumference. Accompanying the spore-mother-cells are smaller starch-bearing sterile cells probably equivalent to elaters morphologically, but lacking a spiral band, these more or less shriveled and obscure at the maturity of the spores.

Key to the Species.

Spores permanently united in tetrads, the surface of these regularly areolate; ♀ involucre 1.2–2.6 mm. high, oblong-cylindrical, fusiform-clavate, or very rarely subpyriform, more or less pointed at the apex, cells near the middle 90–150 $\mu \times$ 30–50 μ. *S. Californicus.*

Spores separating long before the maturity of the capsule, their surface typically cristate, less commonly irregularly and sparingly areolate; ♀ involucre .85–1.2 mm. high, subglobose or obovoid, rounded at the apex, cells near the middle 45–80 $\mu \times$ 30–40 μ. *S. cristatus.*

1. SPHAEROCARPUS CALIFORNICUS Aust. Bull. Torr. Bot. Club, **6**: 305. 1879.

Sphaerocarpus Berteri Aust. *p. p.* Hep. Bor.-Am. 138. 1873. Not Mont. Ann. Sci. Nat. Bot. II., **9**: 39. 1838.

Sphaerocarpus Michelii Bell., var. *Californicus* Aust.; Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 30. 1884.

Sphaerocarpus terrestris Mich., var. *Californicus* Underw. Zoe, **1**: 364. 1890.

♀ thallus suborbicular, somewhat stipitate, mostly 4–8 mm. in diameter, commonly in thickly gregarious masses, the often leaf-like lobes almost entirely concealed by the involucres, these 1.2–2.6 mm. high, oblong-cylindrical, fusiform-clavate, very rarely subpyriform, sessile, more or less acuminate, the orifice usually inconspicuous; marginal cells of the thallus about 45 μ, medial surface cells 60–90 μ, cells near mouth of ♀ involucre 45–60 μ, near the middle, 90–150 $\mu \times$ 30–50 μ: ♂ thallus oblong, commonly furcate or subpalmately parted, the flask-shaped antheridial involucres .27–.36 mm. high: capsule .5–.7 mm. in diameter, seta scarcely perceptible at maturity, the foot commonly remaining in thallus when the capsule is detached; spores permanently united in tetrads, these 105–140 μ (mostly 120 μ) in diameter, dark brown, areolate, the meshes almost regularly pentagonal or hexagonal or somewhat elongated, 15–30 μ in diameter, the tetrad appearing crenulate or slightly papillate in optical section owing to the somewhat increased elevation of the ridges at the angles of the meshes, the entire surface very minutely granulate; sterile cells subspherical to irregularly oblong-cylindrical, 30–60 μ in longest diameter, evanescent at maturity of the spores.

Exsicc. Hep. Bor.-Am. 138 (*p. p.*).

On flat compact soil in meadows and besides paths, less commonly on moist banks. Berkeley ; San Francisco ; Mill Valley; Stanford University (Campbell), Reche Cañon, vicinity of San Bernardino (Parish, no. 3613); Pasadena (McClatchie). Collected also by Brewer and by Bolander.

Sphaerocarpus Californicus is closely related to *Sphaerocarpus Sphaerocarpus* (Dicks.),* differing chiefly in the longer and more pointed cylindrical-oblong or fusiform-clavate involucres, which in the latter species are commonly pyriform.

PLATE 100.

Figs. 9–12, *Sphaerocarpus Californicus.*
All figures are drawn from specimens collected in Mill Valley, Marin Co.
9. ♀ plant, with matured sporogonial involucres, natural size.
10. ♂ plant, × 12.
11. Portion of ♀ thallus with involucres of various ages, × 23.
12. Spore-tetrad, × 305.

2. **Sphaerocarpus cristatus** sp. nov.

♀ thallus suborbicular, 3–8 mm. in diameter, marginal cells of the unistratose lobes 30–45 μ, medial 45–60 μ: involucres .85–1.2 mm. high, sessile, thickly aggregated, at first cylindrical-oblong, soon becoming subglobose or obovoid, rounded at the apex, irregularly circumscissile with age at about the middle or the upper portion falling away in fragments, cells near the usually conspicuous orifice 30–40 μ, near the middle 45–80 μ × 30–40 μ: ♂ plant often once furcate with oblong-ovate segments : capsule .5–.8 mm. in diameter, on a seta about 40 μ in length, the bulbous foot usually accompanying the capsule when this is detached from the thallus ; spores separating long before the maturity of the capsule, never persisting in tetrads, compressed, rounded-biconvex or sometimes concavo-convex, yellowish-brown, 65–80 μ in maximum diameter, cristate, the crests sinuous, 4–7 μ high, subcrenulate, 18–22 in number in the basilar circumference, mostly radiating from near the middle of each of the two faces, often 1–3 times furcate, sparingly anastomosing, forming sometimes 1–6 (rarely more) completely closed meshes in most cases near the middle of

* *Targionia Sphaerocarpus* Dicks. Pl. Crypt. 1 : 8. 1785.
Sphaerocarpus terrestris, minima, Mich. Nov. Pl. Gen. 4. *pl. 3.* 1729.
Spaerocarpus Michelii Bell. App. ad Fl. Pedem. 52. 1792 (*fide auctorum*). Mém. Acad. Roy. Sci. Turin, 5 : 258. 1793.
Sphaerocarpus terrestris Sm. Eng. Bot. *pl. 297.* 1796.

the face; sterile cells cubico-spherical to oblong-cylindrical, 45–70 μ in longest diameter, obscure at maturity of the spores.

Exsicc. Hep. Am. 160 (as *Sphaerocarpus terrestris* Mich., var. *Californicus* Aust., a little of which is intermingled in the three sets examined).

California: near Stanford University,* May, 1892 (Professor D. H. Campbell); Berkeley, Feb. 15, 1896 (Howe).

Sphaerocarpus cristatus is a very remarkable species with no near relatives, so far as can be ascertained from accessible literature and specimens. The spores separate very early—at a time when they are still colorless and only 40–50 μ in diameter and when the surface markings have become scarcely visible. This early dissolution of the tetrad is a character of almost generic importance yet the gap in this respect between *Sphaerocarpus cristatus* on the one hand and *Sphaerocarpus Californicus* Aust. and *Sphaerocarpus Sphaerocarpus* (Dicks.) on the other, in which, so far as we have observed, the spores are *permanently* united in 4's, is bridged over somewhat by *S. Donnellii* Aust., from Florida, in which the spores separate at maturity. But the spores of *S. Donnellii* are quite different in their more angular outline and in their markings, being areolate instead of typically cristate and being also prominently tuberculate-papillate in the basilar circumference.

Professor Campbell (Erythea 4: 73–77. 1896) was the first to observe and record the separation of the spores in Californian specimens of *Sphaerocarpus* and it seems probable from his description and drawings that his interesting "Notes on *Sphaerocarpus*" (*l. c.*) were based, chiefly at least, upon *S. cristatus*.

Hep. Am. 160 in the herbarium of Professor Underwood we would name as the type of the species.

PLATE 100.

Figs. 1–8, *Sphaerocarpus cristatus*.

All figures are drawn from the type material.

1. ♀ plant, with matured involucres and sporogonia, natural size.
2. Portion of thallus with involucres of various ages, × 23.
3. Sporogonium, × 23.

*The locality given in Hep. Am. 160 is "San Mateo Co.," but Professor Campbell writes in reply to a request for a more precisely defined station that nearly all his Hepaticae have been collected within the limits of Santa Clara County, in which Stanford University is situated.

4 Antheridial involucre, × 23.

5 and 6. Opposite faces of a single spore, × 305 (the former is thought to be what was originally the outer face, chiefly because the ridges are here a little the stronger The number of completely closed meshes in the latter is unusually great).

7 and 8. Spores, × 305, the latter showing the flattening.

12. GEOTHALLUS Campb. Bot. Gaz. **21**: 13. *pl. 2.* 1896. Ann. Bot. **10**: 489. *pl. 24, 25.* 1896.

Gametophore transitional in character between the thalloid and foliose types of Hepaticae, consisting of a simple or dichotomous flattened axis several layers of cells in thickness, passing somewhat abruptly at the sides into large crowded irregularly succubous mostly unistratose leaf-like expansions and often bearing smaller irregularly disposed leaf-like laminae on the dorsal surface; cells large, thin-walled; root-hairs numerous, long, colorless. Dioicous. ♂ and ♀ plants similar, or the former slightly smaller. Sexual organs usually few, often standing near the axils of the leaf-like lobes, enclosed, in most cases singly, by unistratose involucres. Antheridia ovoid, on very short stalks, these composed of more than a single vertical series of cells, involucre flask-shaped. Archegonial involucres at first cylindrical or somewhat flask-shaped, becoming saccate or campanulate at maturity of the sporogonium, the orifice large. Calyptra mostly of two layers of cells, ruptured rather late, the upper part, with the archegonium-neck, persisting on the apex of the capsule.

Sporogonium consisting of a nearly spherical indehiscent capsule, a very short seta, and a bulbous foot. Capsule wall of a single layer of large, dark-colored cells, without annular or other local thickenings. Spores separate at maturity, very large, thick-walled, the inner face reticulate, otherwise smooth, accompanied by oval or ellipsoidal-cylindric, thin-walled, sterile cells.

1. GEOTHALLUS TUBEROSUS Campb. *l. c.*

Plant simple or once dichotomous, 5–7 mm. long, 3–5 mm. wide, perennial through the conversion of a large portion of its axis into an oval or flattened tuber: leaf-like lobes nearly horizontal or somewhat ascending, extremely variable in form, mostly oblong, obovate, or linear-ligulate, 1.5–2 mm. in length, rarely broader than long, sometimes cristate-laminate at base, the margins entire or slightly sinuate; marginal cells pentagonal, or subquadrate-oblong, 50–65 × 35 μ, the submarginal hexagonal-oblong or irregularly pentagonal, 50–100 μ × 35–60 μ, those toward the base of the lobes often becoming over 200 μ in length: ♂ involucre .45 mm. in height: capsule .8 mm. in diameter, seta about

90 μ long; spores nearly black, 120–150 μ in maximum diameter, spore-wall smooth or very minutely punctulate and very thick (8–12 μ) except as to the comparatively small inner face where it is thinner and bears reticulate ridges, the meshes about 15 μ in width; sterile cells 48–108 μ long.

On sandy soil, near San Diego (Mrs. Katharine Brandegee; March, April, 1895), associated with *Ophioglossum nudicaule*.

A remarkable plant, clearly allied to *Sphaerocarpus*, yet as clearly distinct from it generically. Living laboratory-grown specimens, bearing antheridia and archegonia, and mounted microtome sections of the mature sporogonium, have been furnished us through the generosity of Professor Campbell. Mature ♀ involucres we have not seen and our description of these is adopted from the author's description with the assistance of his figure 5 (Bot. Gaz. *l. c.*). We have seen the spores only in microtome sections, yet it seems certain from these that the spore-surface is reticulate upon the inner face and otherwise practically smooth, as described by Professor Campbell—a unique character, so far as our observations upon the Hepaticae go. In *Anthoceros*, *Riccia*, *Fossombronia*, etc., it is always the outer face of the spore that is the more conspicuously roughened. Doubtless the restriction of the ridges in *Geothallus* to the inner face is correlated in some way with the unusual thickness and rigidity of the spore-wall in the region of the outer face, especially as the ridges of the inner face are seen in section to be formed by a folding of the exospore, the contour of which is followed by the episporic coating.

The gametophore of *Geothallus* (as grown in the laboratory) much resembles in general appearance that of *Fossombronia longiseta*, though the "leaves" are stiffer, less crisped, and more horizontal.

The formation of tubers is a character which this hepatic shares with *Anthoceros dichotomus* Raddi, *Anthoceros Donnellii* Aust., *Anthoceros tuberosus* Tayl., *Anthoceros phymatodes* M. A. Howe, *Riccia vesicata* Tayl. (= *R. cancellata* Tayl. *fide* Stephani), *Riccia perennis* Steph., *Riccia bulbifera* Steph., *Petalophyllum Preissii* Gottsche, *Petalophyllum lamellatum* (Hook.) Lindb., and *Fossombronia tuberifera* Goebel. The stem of *Fossombronia longiseta* also is often more or less tuberously thickened at the apex, especially in specimens from the southern part of Cali-

fornia. This adaptation for carrying the plant over a season of drought will doubtless be found, when the species from the more arid regions of the earth come to be better known, to be more common among the Hepaticae and Anthocerotes than has been generally supposed, as has already been remarked by Herr Stephani. From the above showing it will be seen that the occurrence of tubers in *Geothallus* can receive no emphasis in the generic diagnosis, inasmuch as this is elsewhere evidently a specific rather than a generic character.

13. RICCARDIA S. F. Gray, [as *Riccardius*] Nat. Arr. Brit. Pl. 683. 1821.

Aneura Dumort. Comm. Bot. 115. 1822.

Gametophore a pinnately, palmately, or subdichotomously branched, rarely almost simple, somewhat fleshy thallus, composed, for the most part, of several layers of cells, with the interior cells considerably larger and more elongated than those of the surface, usually undifferentiated into costa and lamina though sometimes provided with a unistratose border, this, in its best development, giving the thallus, especially the younger branches, the appearance of being broadly costate. Root-hairs few. Monoicous, dioicous, or rarely paroicous, occasionally, perhaps, polyoicous. Antheridia spherical, immersed singly in loculi, commonly arranged in two parallel rows on a small, rounded, or most often, oblong or linear, lateral branch. Archegonia several, on a short subovate lateral branch, this by subsequent growth of the main thallus sometimes appearing to be attached ventrally; margin of the ♀ branch usually furnished with numerous narrow laciniae, these often produced into single rows of cells; base of the archegonium confluent with the thallus, the latter contributing more or less to the formation of the "calyptra." Calyptra tubular or pyriform, large, fleshy, its walls several layers of cells in thickness, the surface roughened near the apex when young [exc. in *Riccardia pinnatifida* (?)] by stout papillae or short trichomes. Involucres external to the calyptra represented only by the fringed margin of the ♀ branch, this becoming more or less coalesced with the base of the calyptra and usually quite inconspicuous.

Sporogonium an oval or oblong-ellipsoidal capsule on a somewhat long seta. Capsule before dehiscence with a short internal axile column at the apex, formed as if by continuation of the inner of the two layers of cells composing the capsule-wall, this column separating, on dehiscence, into four parts—the "elater-bearers"—

one portion remaining attached to the apex of each valve. Elaters unispiral, mostly somewhat attenuate at the ends, a few usually clinging to the "elater-bearers" and forming with them at the tip of each valve a pencil-like tuft. Inner layer of the capsule-wall with annular or spiral thickenings. Spores small.

Key to the Species.

Main axis of the thallus 3–6 mm. wide. 1. *R. pinguis.*

Main axis or principal branches less than 2 mm. wide.

Ramification pinnate.

Unistratose margin of branches one cell in width, obsolete in older parts. 2. *R. major.*

Unistratose margin of branches two or three cells in width. 3. *R. multifida ambrosioides.*

Ramification palmate.

Thallus translucent when moist, surface cells 45–118 × 29–50 μ, branches with unistratose margin one cell in width; monoicous. 4. *R. latifrons.*

Thallus opaque, surface-cells 23–59 × 15–29 μ, branches narrower, usually without trace of a unistratose margin, almost always gemmiferous at apex; dioicous. 5. *R. palmata.*

1. RICCARDIA PINGUIS (L.) S. F. Gray (as *Riccardius*), Nat. Arr. Brit. Pl. 1: 684. 1821.

Jungermannia pinguis L. Sp. Pl. 1136. 1753.

Aneura pinguis Dumort. Comm. Bot. 115. 1822.

Thallus broad, thick, rigid on drying, dull green, with a somewhat greasy lustre, simply pinnate or subpinnate, the main axis 3–6 mm. wide, apices rounded: dioicous: androecia suborbicular, becoming short-oblong, .76–1.7 mm. × .85 mm., often geminate, margin entire or crenulate; antheridia 4–13, irregularly disposed: ♀ branch with a laciniate margin, archegonia few; calyptra 3.5–5 mm. high, tuberculate or nearly smooth: capsule oval, brown; elater-bearers conspicuous, ¼–⅓ the length of the valves; elaters contorted, mostly 145–300 μ × 9–12 μ; spores brown, minutely papillose, 18–24 μ.

In mountain streams and very wet places. Hay Fork, Trinity Co. (no. 1119); Marin Co. (Underwood).

The larger simpler forms of this species may, when sterile, be confused with certain sterile conditions of the genus *Pellia*. Distinguishing marks are, the pinnate, instead of dichotomous, branching, apices rounded rather than emarginate, texture more rigid when dry, and a lustre as if saturated with some oleaginous compound. The sporogonium has not been found in the Californian

specimens. The above description has been completed from New York plants in herb. Underwood.

2. RICCARDIA MAJOR (Nees) Lindb. Musc. Scand. 5. 1879.

Aneura multifida major Nees, Naturgesch. Eur. Leberm. 3: 450. 1838.

Thallus rather broad (main axis .66–1.7 mm. wide), the branching sometimes regular and compact but more frequently loose and irregular, always pinnate or bipinnate; ultimate branchlets usually slightly biconvex but becoming plane or even concave ventrally or dorsally, the unistratose margin one cell in width, obsolete in the older portions: monoicous: androecium usually distant from ♀ branch, rather short, oblong or subovate, .23–.6 × .17–.32 mm., furnished with an erect, translucent, crenulate margin and bearing 1–6 (usually 3) pairs of loculi: ♀ branch broad, its margin multilaciniate; calyptra arcuate, clavate-cylindrical, 2.5–4.5 mm. high, .84–1.26 broad above, much roughened when young by short tubular trichomes, nearly smooth at maturity: capsule oblong-ellipsoidal, dark-brown or black; elater-bearers about $\frac{1}{7}$–$\frac{1}{9}$ the length of the valves*; elaters mostly 290–500 μ long, 12 μ in maximum width, the spiral band disappearing in the gradually attenuate ends, a few (from near the elater-bearers?) 180 × 15 μ, obtuse; spores brown, minutely papillose, 14–18 μ.

Exsicc. Hep. Am. 26 (as *Aneura pinnatifida* Nees).

Common in the Coast Range Mountains on moist banks and on logs and stones about streams. Mill Valley (1185, 1186), Marin Co.; Cazadero (1212) and Duncan's Mills (1213), Sonoma Co.; Ukiah (744), Navarro (Miss Edith S. Byxbee), and Mendocino (550), Mendocino Co.; Blue Lake, Humboldt Co.; Hay Fork (1118), Trinity Co.

So far as California is concerned, this plant is usually very distinct from *R. multifida ambrosioides* and it has seemed conducive to clearness to follow Lindberg in treating the variety of Nees as a species. Yet it must be admitted, we think, that transitional forms do occur in California, though rarely.

Riccardia pinnatifida we do not yet recognize from California. Hep. Am. no. 26, from Marin Co. seems to go better with *Riccardia major*. *Riccardia pinnatifida* differs from the latter species in the

* In measuring the "elater-bearers" the term is here restricted to the somewhat compact column made up of rigid tubes with annular or spiral thickenings and with the free extremities rounded.

softer, flatter thallus, without indication of a unistratose margin, in the looser texture, and according to authors, in being dioicous and in having a smooth calyptra. All specimens of *Riccardia pinnatifida* that we have had an opportunity of studying have, unfortunately, been sterile. It appears to be an aquatic plant, for the most part.

3. RICCARDIA MULTIFIDA AMBROSIOIDES (Nees) Lindb. Acta Soc. Sci. Fenn. **10**: 511. 1875.

Aneura multifida ambrosioides Nees, Naturgesch. Eur. Leberm. **3**: 450. 1838.

Thallus bi- or tri-pinnate, often expanding to form radiating clusters or half-rosettes, the branches crowded, rather narrow (.34–.85 mm. broad), biconvex with a unistratose margin two or three cells in width, thus presenting a quite clearly defined suggestion of a costa: monoicous, sometimes paroicous (rarely dioicous?): androecium usually distant from ♀ branch, oval, oblong, or linear, .65–.93 × .25–.33 mm., with a hyaline crenulate margin, and bearing 3–7 pairs of loculi, or 2 or 3 antheridia sometimes immersed in base of the ♀ branch (paroicous): margin of ♀ branch with copious laciniae, each commonly ending in a single row of cells; calyptra much roughened, 3–4 mm. high: capsule brown, oblong-ellipsoidal; elater-bearers about $\frac{1}{15}$ the length of the valves; elaters mostly 250–480 μ long, 18 μ in greatest width, attenuate at the ends; spores 15 μ, nearly smooth.

On decaying wood and moist banks. Olema (1187), Mendocino (586, 666), Eureka (964) and Hay Fork (1188). The last-mentioned specimen seems to be strictly dioicous, and a tendency to restriction of the two kinds of organs to separate individuals is sometimes to be observed in our other Californian specimens. The description of the sporogonium is drawn from no. 944, Jack, Leiner and Stizenberger, Kryptogamen Badens.

4. RICCARDIA LATIFRONS (Lindb.) Lindb. Acta Soc. Sci. Fenn **10**: 513. 1875.

Aneura latifrons Lindb. Not. pro Fauna et Flora Fenn. **13**: 372. 1874.

Thallus light green or darkening on drying, translucent when moistened, palmately divided; the ultimate branches oblong or linear, usually 2–4 mm. long, .83–1.32 mm. wide, commonly strongly emarginate, slightly convex dorsally, plane or subconcave

beneath, without suggestion of a costa, the unistratose margin only one cell in width, very rarely gemmiferous at apex; surface-cells pentagonal, hexagonal or irregularly oblong, large, pellucid, 45–118 × 29–50 μ: monoicous: androecium affixed to base of ♀ branch or distant, oblong, .66–.85 × .27–.33 mm., somewhat narrowed at base, with an erect laciniate margin, loculi about five pairs: ♀ branch with numerous small marginal laciniae mostly composed of a single row of cells; calyptra pyriform-clavate, slightly verrucose near apex, 2.5–3.5 mm. high, .75–1 mm. broad above: elaters 120–240 μ long, 15 μ in maximum width; spores brownish-green, minutely papillate, 13–21 μ.

On decaying logs. Redwood Cañon, Marin Co. (1184); Navarro (Miss Edith S. Byxbee) and Mendocino (592, 721, 676); Kneeland Prairie, Humboldt Co. (1023); near Hay Fork, Trinity Co. (1112, 1129); Sisson, Siskiyou Co. (39). The species was collected in California by Dr. Bolander, also, the exact locality unknown.

Lindberg's original description seems to call for a larger plant than ours, yet the Californian specimens agree very closely with G. & R. Hep. Eur. no. 493 and Sulliv. Musc. Allegh. no. 279, which were referred to *R. latifrons* by Lindberg, and also with specimens collected in Sweden by Arnell.

The branching may be subpinnate below, but ultimately is always pronouncedly palmate or subdichotomous.

5. RICCARDIA PALMATA (Hedw.) Carruth. Seeman's Jour. Bot. 3: 302. 1865.

Jungermannia palmata Hedw. Theor. Gen. 87. *pl. 18. f. 93–95.* 1784.

Thallus opaque, compact, dark green on drying, palmately branched or subdichotomous, usually without trace of a unistratose border, almost always bearing gemmae at apices both dorsally and ventrally; gemmae of two cells, formed endogenously from cells of the surface; surface-cells small, quadrate-rhombic or oblong-pentagonal, 23–59 × 15–29 μ: dioicous: ♂ thallus narrow, biconvex, sometimes nearly terete, the branches .18–.35 mm. in width, rounded at apex or slightly notched; ♀ plants broader and larger, the segments .5–1 mm. wide: androecia oblong or linear, often in pairs, .5–1.1 × .25–.32 mm., with entire inflexed membranous margins, sometimes proliferous at apex, loculi 4–8 pairs at maturity: ♀ branch subentire, or with a few short and incon-

spicuous marginal laciniae, rarely proliferating, archegonia 5–18; calyptra strongly tuberculate: spores small, almost smooth, brownish-green.

On old logs. Russian Gulch, near Mendocino (715) and at Sisson (50—associated with *R. latifrons*).

We have observed no calyptra or sporogonium in the Californian plants and for the description of these parts have depended upon authors, especially Lindberg and Limpricht.

In *R. palmata*, nearly the entire surface-layer of the thallus sometimes becomes resolved into gemmae, after which the plant appears more translucent and as if composed of larger cells.

In one case alone out of many preparations from the specimens cited, we have seen what may have been a monoicous individual, but here we were unable to determine with certainty whether the union was really organic or due simply to adhesion.

METZGERIA Raddi, Atti Soc. Ital. Sci. Mod. **18**: —(34). 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 45. 1820.

In the manuscript on the Californian Hepaticae prepared by Dr. Watson and Mr. Austin (see page 10), there is to be found a short description of *Metzgeria conjugata* Lindb., followed by the remark: "A few fronds, insufficient for proper determination, but apparently agreeing with this description, were found among the specimens of *Frullania Grayana*, var., collected by Bolander." A "*Metzgeria furcata* Nees" is included among the seven Hepaticae enumerated by Sullivant in the Report on the Botany of Whipple's Expedition,* but whether this was collected within the limits of California or not is a matter of uncertainty. As we have seen no California specimens of *Metzgeria*, we will not attempt any description of its species. It is hoped that the brief diagnosis given in the key to the genera of the *Metzgeriaceae* will suffice for the recognition of the genus. At least two species of *Metzgeria* occur farther to the northward on the Pacific Slope, and there is little doubt that the genus is represented in California.

14. PELLIA Raddi, Atti Soc. Ital. Sci. Mod. **18**: —(38). 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 49. 1820.

Gametophore a thin or somewhat fleshy, irregularly dichotomous, undulate-margined thallus without ventral scales, growing in thick masses with imbricate-ascending lobes or scattered, bright

* Pacific R. R. Survey, 4: 191. 1857.

green, darkening with age or on drying, usually soft and flaccid when soaked out, furnished with a broad, for the most part indistinctly defined costa (9–16 cells in thickness), this passing gradually into the wide unistratose somewhat sinuate-lobed margin; root-hairs springing from the costa, brownish, numerous. Monoicous or dioicous. Antheridia oval, short-stalked, immersed, usually singly, in loculi irregularly distributed along the dorsal surface of the costa. Archegonia in groups of 4–18, borne in a pocket-like cavity near the apex of the costa, becoming dorsal by the subsequent growth of the thallus, covered more or less by an involucre opening in front. Involucre at maturity of sporogonium a mere flap or scale at the posterior margin of the cavity or becoming tubular or forming a short and narrow ring, the margin crenulate or lacerate. Calyptra exserted from the involucre or included, its walls composed of several layers of cells.

Sporogonium consisting of a spherical, light brown or yellowish, 4-valved capsule on a very long delicate seta; capsule-wall bistratose, cells of the outer layer with yellowish-brown trigones or nodular thickenings, those of the inner layer with semiannular or imperfectly spiral thickenings (wanting or rudimentary in *P. endiviaefolia*), "elater-bearers" and elaters both present, the former 20–100 in number, persistently attached to the base of the capsule, 1–6-spiral, differing more or less in character from the true elaters; the latter 2–4-spiral, mostly rather obtuse, often, together with the spores, remaining for a time clinging to the elater-bearers and forming a globular entangled mass at the base of the valves. Spores very large, multicellular at the time of dehiscence, oval or ellipsoidal, punctulate.

1. PELLIA NEESIANA (Gottsche) Limpr.; Cohn, Krypt. Fl. Schles. **1**: 329. 1877.

Pellia epiphylla, forma Neesiana Gottsche, Hedwigia, **6**: 69. 1867.

Dioicous: ♀ plants somewhat sparingly dichotomous, with oblong or linear branches; ♂ plants forming dense mats with numerous broad crenate overlapping ascending segments: involucre forming a short tube, 1–2 mm. high, with a lacerate margin; calyptra exserted 1–3 mm.: capsule 1.5 mm. in diameter on seta 3–5 cm. long; cells of inner layer of capsule-wall with often imperfect semiannular thickenings; contents of capsule in part persisting for some time after dehiscence in an intertangled globular central mass; elater-bearers about 30, stout, conical- or blunt-pointed, 120–270 μ × 18–36 μ, mostly 3- or 4-spiral, sometimes bispiral or annulate; elaters strongly contorted, 2-, or more rarely,

3-spiral, 225–400 μ × 9–12 μ; spores 84–105 μ × 51–69 μ, 4 or 5 cells in length and 2 or 3 in greatest width.

On banks of streams, along the North Fork of the Little River, Mendocino Co. (605, 654, 657).

Pellia epiphylla (L.) Corda and *P. endiviaefolia* (Dicks.) Dumort.* may both occur in California. *P. epiphylla* differs from *P. Neesiana* in being monoicous and in the reduction of the involucre to a scale or flap on the posterior margin of the cavity from which the calyptra arises. *P. endiviaefolia* [*P. calycina* (Tayl.) Nees] is dioicous, but differs from both the others in the greater development of the involucre, which forms a tube about 4 mm. high, from which the calyptra scarcely ever protrudes, and is markedly different from both in characters of elaters and elater-bearers, the latter being, according to Jack,† often as many as 100, much longer and more slender (600–800 μ × 5 μ) and bispiral, while the true elaters are shorter than in the other two species (150–200 μ), less contorted, and 3- or 4-spiral. Semiannular thickenings, conspicuous on the inner wall of the capsule of *P. epiphylla* and *P. Neesiana*, are wanting or obscurely developed in *P. endiviaefolia*.

A sterile *Pellia* was collected in 1894 by Messrs. M. S. Baker and F. P. Nutting in the mountains south of Dixey Valley in Lassen Co., but the species is scarcely determinable. Dr. Bolander lists "*P. calycina*" in his "Catalogue of the plants growing in the Vicinity of San Francisco," but we have been able to see no *Pellia* of Dr. Bolander's collecting.

15. BLASIA L. Sp. Pl. 1138. 1753. Ex Mich. Nov. Pl. Gen. 14. 1729.

Gametophore dark- or bluish-green, becoming yellowish, usually several times dichotomous, forming rosettes or irregularly tangled tufts, somewhat transitional in character between the thalloid and foliose types, 5–10 cells in thickness along the narrow or expanded costa, becoming gradually thinner toward the unistratose border, the latter sometimes merely crenulate or sinuate but more often running out into rounded, distant, or close and incubous, leaf-like lobes; root-hairs colorless, springing from the costa, often numerous toward the base and fastening the plant closely to the substratum. Underleaves represented by small, oblong, ovate, or

* Rec. d'Obs. Jung 27. 1835.

† Flora, 81: 6, 7. 1895.

heteromorphic, dentate scales, in an irregular row on each side of the costa, attached by the posterior margin or near the middle with the margins free. On the ventral surface, also, are small, hollow, subspherical organs, the "leaf-auricles," usually two near the base of each lateral lobe, their cavities commonly soon occupied by colonies of *Nostoc*.* Marginal cells of the lateral lobes 20–30 μ, oblong, quadrate, or oval, each often with a salient point, remaining cells of lobe 30–60 μ, rhombic-hexagonal, surface cells of the axial region more elongated. Gemmae of two kinds; one borne in dorsal flask-shaped receptacles formed out of the substance of the apex of the costa and appearing single, paired, or in threes, according to the development of the branch-system, furnished at maturity with a long slender neck (1–2 mm. × .17–.3 mm), the neck-wall 2–4 cells in thickness, the gemmae flattened-oval, 90–135 μ, 3–5 cells wide, 2 cells thick or unistratose at margin, borne on slender hyaline pedicels arising from the base and sides of the receptacle, the pedicels accompanied by short, clavate, unicellular trichomes; second form of gemmae on the dorsal surface of the younger portions of the plant, scale-like, stellate or coarsely dentate, of a single layer of cells near their margin, of two or more layers toward the middle. Dioicous. ♂ plants smaller; antheridia several, immersed singly in a row along the dorsal surface of the costa. Archegonia numerous, on dorsal surface of the costa toward the apex, the single fertilized archegonium becoming, by the arching over of the adjacent parts, completely enclosed within a cylindrical or clavate inflation of the costa, this 3–4 mm. in length, directed forward, finally ruptured at the anterior end by the elongating sporogonium, and functioning as an involucre. Calyptra light-colored, membranous. Capsule oval, dingy brown, 1–1½ mm. long, dehiscing by 4 (4–6) valves, inner surface with annular or spiral thickenings, the outer surface showing brownish nodules in the radial walls; seta rather thick, 1¼–2 cm. long. Spores ovoid or somewhat angular, 38–50 μ, slightly granulate, long remaining with the elaters in a central globular mass. Elaters 200–300 μ × 10–14 μ, with two spiral bands, these often becoming paired by splitting.

The only known species is

1. BLASIA PUSILLA L. *l. c.*

Jungermannia Blasia Hook. Brit. Jung. *pl. 82–84.* 1816.

* The *Nostoc* colonies are thought to live in symbiotic relations with the *Blasia*, perhaps serving as reservoirs of moisture (Goebel, in Schenk's Handbuch der Botanik, 2: 360. 1882). The colony is surrounded ventrally by a single layer of cells and is penetrated by a branching tube which springs from the wall of the cavity.

Beside a pool, Blue Lake, Humboldt Co. (1002). Our specimen is simply gemmiferous; the above description of the sporogonium is drawn from a Swedish plant collected by Dr. Arnell.

16. FOSSOMBRONIA Raddi, Atti Soc. Ital. Sci. Mod. **18**:— (29). 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 40. 1820.

Gametophore consisting of a creeping, simple, furcate, or innovating stem with 2-ranked, obliquely inserted succubous leaves. Stem flattened above, closely attached to the substratum by very long, mostly violet- or vinous-purple root-hairs. Leaves assurgent or subvertical, undulate-crisped, especially on drying, usually imbricate, subquadrate, often broader than long, the bases extending far onto the dorsal side of the stem and more or less decurrent, margins in most cases irregularly sinuate-lobed, sometimes toothed, rarely subentire; small subulate paraphyllia-like appendages often occurring, especially on dorsal surface of the stem; leaf-cells large, thin-walled, often in two or more layers near the base, cuticle smooth. Monoicous (commonly heteroicous, *i. e.*, paroicous and synoicous), sometimes dioicous. Antheridia spherical or oval, on about equally long stalks, standing singly or in groups of 2–4 on the dorsal side of the stem near the bases of the leaves. Archegonia similarly situated (the fertile one, however, always near the stem-apex), single or in groups of several, sometimes closely associated with the antheridia. The fertilized archegonium becoming surrounded by a large campanulate or goblet-shaped involucre, this commonly open or incised to the base in front (*i. e.*, toward the stem-apex), the wide mouth undulate-lobed or dentate. Involucre often surrounded by several small subulate or linear-lanceolate scales, these in most cases finally adnate to the involucre and forming slight wing-like ridges. Calyptra free, thin.

Sporogonium a spherical capsule on a short, rarely somewhat elongated seta arising from a subglobose "foot." Capsule brown or when young and living nearly black, irregularly dehiscent or imperfectly 4-valved, the wall bistratose, cells of the inner layer with often incomplete semiannular thickenings. Spores large, several times broader than the elaters, round tetrahedral, somewhat flattened, the outer face echinate, verrucose, reticulate-alveolate, or bearing free or anastomosing crests, the small inner faces much less strongly roughened, in most cases simply punctate, verrucose-papillate, or marked with short, low ridges. Elaters usually 2- or 3- (1–4-) spiral.

1. FOSSOMBRONIA LONGISETA Aust. *p. p.* [as synonym] Proc. Acad. Nat. Sci. Philad. 1869: 228. 1869.

Androcryphia longiseta Aust. *l. c.*

Stems mostly 6–15 mm. long and once dichotomous, rather stout (15–20 cells in thickness), commonly somewhat tuberously thickened at apex and perennial through the resumption of apical growth on termination of the dry season, root-hairs vinous-purple: leaves 1.5–3 mm. long, subquadrate, assurgent or nearly horizontal, more or less imbricate, irregularly lobed, toothed, or subentire, often of 2–5 layers of cells toward the base; leaf-cells 30–45 μ × 40–60 μ near the margin, 40–60 μ × 60–150 μ near the base; monoicous (polyoicous?): involucre usually large, 1.5–3 mm. high, campanulate, open to the base on the side toward stem-apex or often connate here forming a complete cup, usually with several subulate squamules adnate to the outer surface, these mostly short but sometimes reaching nearly to the lobate-dentate mouth: seta finally 8–18 mm. long; capsule 1–1.2 mm. in diameter, the semi-annular thickenings of the inner layer of the wall mostly incomplete: spores yellowish-brown, distinctly compressed, 38–50 μ* in maximum diameter, strongly and somewhat remotely cristate, the crests high, projecting 3–6 μ at the margin, 20–30 in number in the basilar circumference, more or less obliquely ascending, slightly flexuous, thin, acute, usually undulate-serrulate, unequal in length, disappearing or sparingly confluent at the middle of the face, forming there very rarely 1–3 fully closed meshes; crests sometimes mostly replaced by subacute or truncate spines, these often numerous and crowded, 30–40 in number in the basilar circumference: elaters bispiral, 150–270 μ in length.

On banks and beside paths. Clarendon Heights, San Francisco; Mill Valley, Mt. Tamalpais, and Lake Lagunitas, Marin Co.; Duncan's Mills, Sonoma Co.; Ukiah (743, 785), Mendocino Co.; Blue Lake (998), Humboldt Co.; Lake Pilarcitos, San Mateo Co.; Reche Cañon, San Bernardino Co. (Parish, no. 3614); Pasadena (A. J. McClatchie); San Diego (Mrs. Katharine Brandegee). Collected also by Dr. Bolander; and by Prof. W. H. Brewer at "Egon Pass" (in herb. W. H. Pearson).

EXSICC. Hep. Bor.-Am. 118 (*p. p.*?).
Hep. Am. 157.

The "type specimen" of *Fossombronia longiseta* appears not to exist either in that portion of the Austin collection owned by

* Measuring to the extremities of the crests.

Mr. Pearson or in that in possession of the Owens College at Manchester. The species was distributed by Mr. Austin a few years after its publication as no. 118 Hep. Bor.-Am., but we have been unable to examine the spores in this, owing to the imperfect and fragmentary condition of the only specimen we have seen. Here, as after the original description, Texas as well as California was cited as furnishing the species, but the Texas plant, according to Lindberg (who gave it the name *F. Texana*), would appear to be quite a different thing, having areolate spores and being thus allied to *F. angulosa*. A specimen of *F. longiseta*, which may be a portion of the original material studied by Mr. Austin, is to be found in herb. Underwood marked "California, ex herb. C. F. Austin, comm. O. D. Allen." The original description, it should be noted, calls the species *dioicous*, while our specimens can, in most cases, be shown to be *monoicous*; yet capsule-bearing plants are sometimes found which exhibit numerous abortive archegonia on the back of the stem without traces of antheridia in any part. The two kinds of organs seem never to be closely associated in this species. Plants collected on January 7, 1896, near Lake Lagunitas, Marin Co., which we believe to be of this species, though not spore-bearing, show numerous antheridia along the back of the stem, and, from the examination with a pocket lens at the time of gathering, the specimens were thought to be purely ♂, but it was demonstrated on dissection that each bore also a number of archegonia near the stem-apex. The truth in the matter seems to be that the plants are perennial in most cases at least and that each plant has alternating periods of archegonia- and antheridia-production and that the two successive periods of production of either organ may sometimes be quite widely separated.

Fossombronia longiseta is allied to *F. pusilla* (L.) Dumort. and *F. Wondraczeki* (Corda) Dumort. (*F. cristata* Lindb.), but is sufficiently distinct from both in the longer seta, the rather larger leaves and leaf-cells, the arrangement of the sexual organs, probably in the perennial habit, and, in most cases at least, in the spore-markings. The crests of the spores are usually high, as in *F. pusilla*, but are commonly more numerous and often show a tendency to become broken up into spines, thus affording a transition to the purely echinate type of *Fossombronia* spore. The spore-

markings are extremely variable, and it is possible that two or more species should be recognized in the Californian specimens, but we have been unable to draw separating lines in any satisfactory way. The difference between a purely and rather remotely cristate spore like that represented in our figure 18 and one in which the crests are nearly all replaced by narrow spines, very numerous and densely crowded in the basilar circumference, like that shown in fig. 20, is very striking, but forms that seem to be intermediate exist, as is shown by our other figures. It is worthy of remark that the spores (fig. 17) of the specimen "ex herb. C. F. Austin," alluded to above, bear more spines than crests; the spines are here somewhat shorter than in specimens from the southern part of the state [Pasadena (McClatchie); San Bernardino Co. (Parish)]. All the specimens that we have seen from stations north of San Francisco have spores of the purely cristate type, having, on the whole, more in common with the spores of *F. pusilla* than with those of *F. Wondraczeki.*

PLATE 99.

16–20. *Fossombronia longiseta* Aust. Spores, × 305.

16. From Clarendon Heights, San Francisco, Mar. 28, 1896.

17. From specimen in herb. Underwood marked "California, ex herb. C. F. Austin, comm. O. D. Allen."

18. From Mill Valley, Marin Co., Apr. 4, 1896.

19. From specimen in herb. Underwood, marked "San Francisco, Cal., coll. T. S. Brandegee."

20. From Pasadena (A. J. McClatchie).

Family IV. JUNGERMANNIACEAE.

Apex of the gametophore (or of some of its branches) at length directly transformed into an archegonium. Sporogonia always terminal on the main axis or on the branches. Gametophore a leaf-bearing stem.* Leaves in two lateral rows, in addition to which there is often a ventral row of "underleaves" commonly differing from the lateral in size and form. Antheridia borne in the axils of more or less modified leaves ("♂ bracts"). Archegonia usually surrounded by a special involucre, the "peri-

* In three exotic genera, there is a prominent thalloid or filamentous phase, but this, in two of the cases, at least, is doubtless to be homologized with the protonema rather than with the gametophore. In all, the branches bearing the sexual organs are foliose.

anth," which, in many cases, at least, represents a union of the leaves of the adjacent cycle. The leaves (" ♀ bracts ") and underleaf (" bracteole ") subtending the perianth often somewhat modified.

Capsule quadrivalvate (the valves very rarely again cleft). Elaters always developed in association with the spores.

More than four fifths of all the species of Hepaticae of the world, according to Schiffner, belong to the present family.

Key to the Genera of Jungermanniaceae.*

Underleaves present throughout.

Leaves complicate-bilobed, the ventral lobe much the smaller.

Ventral lobe usually inflated, sac-like, helmet-shaped, or obovoid-clavate, rarely explanate; underleaves bifid. 35. *Frullania.*

Ventral lobe plane or with revolute margins, ovate to linear-lanceolate, sometimes nearly separate from the dorsal; underleaves entire or dentate. 34. *Porella.*

Leaves with 2–5 lobes or teeth, or divided to the base into capillary segments, never acutely complicate.

Leaves bifid or bidentate.

Underleaves much smaller than the leaves and usually different in form.

♀ branch a fleshy almost leafless subterranean sac depending from the ventral surface of the stem; the appressed underleaves bifid to the middle or below, with rather narrow sinus and nearly parallel lobes, otherwise entire. 25. *Geocalyx.*

♀ stem or branch comparatively little modified, conspicuously foliose.

Root-hairs in tufts at the base of the underleaves, the latter deeply bifid, the somewhat spreading segments again cleft or externally unidentate near the base; perianth more or less triangular-prismatic, the third angle always dorsal. 23. *Lophocolea.*

Root-hairs irregularly scattered; perianth triangular-prismatic, at least when young, the third angle always ventral. 26. *Cephalozia.*†

Root-hairs irregularly scattered; perianth ovoid, obovoid, or cylindrical, sometimes slightly compressed laterally, terminal on main stem or leading branches, now and then falsely dorsal. 21. *Lophozia.*

Underleaves similar to the leaves both in form and size. 30. *Anthelia.*

Leaves with 3–5 principal lobes or teeth, these more than one cell wide at base.

Leaves 3- or 4-lobed to about the middle (in our species); the lobes entire, somewhat acute, incurved; underleaves a little smaller than the leaves, otherwise similar; perianth on short branch arising from the axil of an underleaf. 28. *Lepidozia.*

* The present key is based, for the most part, upon the known Californian representatives of the various genera, and may not always apply to extra-limital species.

† Underleaves are rather uncommon in this genus outside of the ♀ branches, where they are always represented.

Leaves 3- or 4-cleft to below the middle; the segments filiform-acuminate, entire or more or less ciliate-fringed; antheridia on the main stem or lateral branches; perianth really acrogenous (*i. e.*, terminal on main stem or principal branches), but finally, through innovation, on a short, falsely lateral branch. 31. *Ptilidium.*

Leaf-lobes 3–5, obtuse, acute, apiculate, or spinescently pointed, the sinuses not extending to the middle; underleaves very different from the leaves, usually deeply bifid and often ciliate-fringed; perianth acrogenous; plants usually large. 21. *Lophozia* (§ *Barbatae*, not yet found in California).

Leaves divided to the base into 2–4 capillary segments; underleaves similar. 29. *Blepharost.ma.*

Leaves entire or merely retuse at apex (sometimes bidentulate in *Kantia*).

Leaves incubous (*i. e.*, the anterior margin covering the posterior margin of the next leaf in front); underleaves suborbicular to ovate, emarginate or bifid; ♀ branch a fleshy almost leafless subterranean sac depending from the axil of an underleaf. 27. *Kantia.*

Leaves succubous (*i. e.*, the anterior margin covered by the posterior margin of the next leaf in front).

Plants with creeping, nearly or quite leafless, rhizomatous primary stems and ascending foliose branches; leaf-margin usually more or less dentate; underleaves minute, subulate and entire or 2- or 3-cleft. 22. *Plagiochila.*

Plants without rhizomatous primary stems; leaves without marginal teeth (but often retuse or bilobed at apex in *Lophocolea heterophylla*).

Root-hairs, when present, in tufts at the base of the underleaves; leaves immarginate; capsules dehiscing by straight valves.

♀ branch very short; the bracts a single pair, with sometimes rudiments of a second, very much smaller than the leaves; androecium on the main stem. 24. *Chiloscyphus.*

♀ branch longer, bracts (♀ and ♂) 3–5 pairs; paroicous. 23. *Lophocolea* (*L. heterophylla*).

Root-hairs long and numerous, springing from nearly all parts of the often reddish-purple ventral surface of the stem; leaves mostly linguiform, margined by a row of enlarged cells, trigones conspicuous; capsule dehiscing spirally, the valves very long and slender. 18. *Gyrothyra.*

Underleaves wanting throughout or present only in association with the ♀ bracts.*

Leaves complicate-bilobed.

Ventral lobe much the smaller; root-hairs springing from a mammilliform outpocketing of the ventral lobe near its base. 33. *Radula.*

Ventral lobe the larger (the two lobes rarely equal); root-hairs springing from the stem.

Perianth strongly compressed dorso-ventrally (parallel with the plane of the "frond"); fold of the leaf usually acute, often alate; root-hairs commonly scanty on the foliose branches. 32. *Scapania.*

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* *Chiloscyphus polyanthos rivularis* may be sought here, inasmuch as the underleaves are commonly destroyed or wanting except in the youngest parts, where, however, they may always be demonstrated.

Perianth not compressed dorso-ventrally, deeply plicate at mouth; leaf folded at about a right angle, the fold rounded; lobes acuminate, obscurely crenulate toward apex; root-hairs long and numerous.
21. *Lophozia* (*L. ovata*).

Leaves with two nearly equal lobes or teeth, never acutely complicate.

Archegonia terminal on the main stem; uppermost pair of ♀ bracts more or less highly connate, enclosing the delicate perianth, to the lower part of which the bracts are adnate; leaves typically transverse.
17. *Marsupella.*

Archegonia usually terminal on short, ventral branches; perianth free from the bracts, much exserted, triangular-prismatic, at least when young, the third angle always ventral; branches, typically, all of ventral origin
26. *Cephalozia.*

Archegonia terminal on the main stem or principal branches; ♀ bracts free from each other and from the perianth; perianth oval to cylindrical-obovoid, never triangular-prismatic, commonly plicate toward the mouth; leaves succubous.
21. *Lophozia.*

Leaves with 3–5 lobes.
21. *Lophozia.*

Leaves entire (or in *Plagiochila* often dentate-margined), never bilobed

Plants with creeping, nearly or quite leafless, rhizomatous primary stems and ascending foliose branches; leaf-margins usually somewhat dentate.
22. *Plagiochila* *

Plants without rhizomatous primary stems; leaf-margins entire or merely repand.

♀ bracts more or less adnate to base of perianth. 19. *Nardia.*

♀ bracts wholly free from perianth. 20. *Jungermannia.*

17. MARSUPELLA Dumort. *p.p.* Comm. Bot. 114. 1822.

Sarcoscyphos Corda; Opiz, Beitr. 652. 1829.†

Nardius S. F. Gray, *pro parte minima*, Nat. Arr. Brit. Pl. 1: 694. 1821.

Plants from large and stout to very small and slender, usually densely caespitose. Stems erect or ascending, very rarely prostrate, subsimple or dichotomously branched, commonly sending out stolons or nearly leafless flagella from near the base, root-hairs in most species infrequent except at base and on the stolons. Leaves patent or erecto-patent, always bilobed; in the typical species transversely inserted, disposed in opposite ranks, canaliculate-concave or subcomplicate-carinate, the plant thus appearing compressed dorso-ventrally; in *M. Bolanderi* often obliquely inserted and distinctly succubous. Underleaves wanting. Usually dioicous or paroicous, rarely autoicous or synoicous. ♀ bracts commonly

* Structures representing underleaves are commonly present in the North American *Plagiochilae* but they are often so minute and fugacious that they may sometimes escape observation.

† See footnote, p. 33.

2–4 pairs, larger and less deeply lobed than the cauline leaves, the inmost pair more or less highly connate at base and fused with the lower part of the perianth and the hollowed-out upper part of the stem to form a somewhat goblet-shaped involucre. Perianth delicate' included in the involucre, irregularly 4–6-lobed after the exsertion of the capsule. Calyptra free or, toward the base, adnate to the perigynial tube. Capsule globose or slightly elongated, the valves of 2 or 3 layers of cells, the walls of which exhibit numerous brown nodular or imperfectly semiannular thickenings. Elaters bispiral.

Key to the Species.

Stems 2–6 mm. long; leaves in sterile and lower part of ♀ plants somewhat obliquely inserted and succubous; median leaf-cells 16–36 μ; antheridia single or in pairs; ♀ bracts nearly always margined with radially elongated cells. 1. *M. Bolanderi.*

Stems 5–80 mm. long; leaves always transversely inserted and canaliculate-concave or subcomplicate; median leaf-cells 16–28 μ; antheridia in groups of 2–6; ♀ bracts very rarely submarginate. 2. *M. emarginata.*

1. MARSUPELLA BOLANDERI (Aust.) Underw. Zoe, 1: 365. 1890.

Sarcoscyphus Bolanderi Aust. Bull. Torr. Bot. Club, 3: 9. 1872.

Nardia Bolanderi Aust.; Underw. Bull. Ill. State Lab. Nat. Hist. 2: 113. 1884.

Densely and intricately caespitose, lurid green or dusky red, often blackening: stems prostrate or ascending at apex, rarely suberect, 2–6 mm. long, .1–.22 mm. in diameter, simple, sparingly branched below, or innovating from the axils of the ♀ bracts, furnished to the apex in most cases (especially in the ♀ plants) with somewhat copious colorless root-hairs: leaves close or distant, variable in size and position, ovate-orbicular, usually broader than long, .14–.36 mm. in length, .22–.55 mm. in width, subtransverse and erecto-patent in ♂ plants and toward the perianth in the ♀, otherwise mostly patulous-subvertical (turned toward the dorsal aspect of the stem) and succubous, sometimes obscurely marginate, concave, occasionally subcomplicate, rarely almost plane, emarginate-bilobed ¼–⅓ their length, the sinus acute or somewhat obtuse, the lobes triangular-ovate, mostly obtuse; leaf-cells rather thin-walled, with small or obsolete trigones, the marginal subquadrate, 16–25 μ, sometimes becoming a little elongated radially, the median mostly rounded-hexagonal, 16–36 μ, cytoplasm in exposed parts containing a diffused reddish-brown pigment: dioicous: antheridia single or more commonly in pairs, on stalks a little shorter than their long diameter, the ♂ bracts often distinctly bordered with subquadrate cells a little elon-

gated radially, the dorsal margins usually subrevolute : ♀ bracts 3 or 4 pairs, rather abruptly 2–6 times larger than the leaves, nearly always distinctly marginate with radially elongated often more highly colored cells 25–45 μ in greatest diameter, median cells oval-elliptical, 25–50 μ; inmost pair of bracts finally the largest, more or less highly connate, forming an exserted perianth-like, cylindrical or goblet-shaped involucre from a somewhat obconical base, emarginate-bilobed (rarely trilobed) 1/8–1/6 their length ; outer bracts transversely inserted, erecto-patent, bilobed 1/6–1/4 their length, otherwise entire or slightly repand, the lobes obtuse : perianth subpyriform, a little shorter than the involucre, free in the upper third or half, with 4–6 connivent lobes at the mouth : calyptra mostly of two layers of cells : capsule dark brown, globose, .4–.45 in diameter, the walls of the cells with very numerous nodular thickenings ; seta 2–4 mm. long.

On or about rocks or on exposed banks, sometimes under chaparral ; hills and ridges of the Coast Range Mountains. San Francisco : Mission Dolores (Bolander), Clarendon Heights (Howe); Mt. Tamalpais and near Lake Lagunitas, Marin Co.; Pieta, Mendocino Co. (804); near Lake San Andreas, San Mateo Co. Often associated with *Cephalozia divaricata*, to which, sometimes, the more slender forms bear a superficial resemblance. Near Lake San Andreas, it grows in company with *Scapania nemorosa*, *Nardia crenulata*, *Cephalozia Turneri*, and *Marsupella emarginata*. It is always readily distinguishable from the smaller conditions of the last-named species by its darker color, the often distinctly succubous leaves, the larger and thinner-walled leaf-cells, the nearly always marginate ♀ bracts, the more exserted perianth-like involucre formed by the inmost pair of bracts, the fewer antheridia to each perigonial leaf, the smaller, darker, and more nearly spherical capsule, etc.

All of the minute European *Marsupellae* described more recently by Limpricht and by Spruce seem to be abundantly distinct from *Marsupella Bolanderi*. The larger and otherwise different *Marsupella sphacelata erythrorhiza* (Limpr.) [under *Sarcoscyphus* in Cohn, Krypt.-Fl. Schles. 1 : 248, 431. 1877] is possibly its nearest ally, judging from specimens kindly communicated by Professor Limpricht.

The often obliquely inserted, subvertical, and distinctly succubous character of the leaves in *Marsupella Bolanderi* serves to

bridge over one of the more important gaps between the genera *Marsupella* and *Nardia* as defined by Spruce and accepted by most of the modern writers on hepaticology.

PLATE 101. MARSUPELLA BOLANDERI.

1. Plants, natural size.

2, 3. Apical portions of plants, showing innovations from axils of ♀ bracts, × 12.

4. Apical portion of a sterile plant, lateral view, showing succubous leaves, × 23.

5–7. Dorsal, lateral, and ventral views of apex of different ♀ plants, showing bracts, etc., × 23.

8. ♂ plant, × 23.

9. ♂ bract and antheridia, × 23.

10. A sterile (♀?) plant, × 23.

11. Cauline leaf, × 23.

12. Cauline leaves, outer (convex) face, × 23.

13. Cauline leaves, inner (concave) face, × 23.

14. Involucre, opened to show perianth and sterile archegonia, calyptra removed, × 23.

15. Margin of cauline leaf, × 225.

16. Part of ♀ bract, from one of the pair next subtending the perianth-like involucre, showing the radially elongated marginal cells, × 225.

Figures 10 and 15 from the original specimen ex herb. Austin; 2, 8, and 9, Mt. Tamalpais; 3, 12, 13, near Lake San Andreas, San Mateo Co.; 4–7, 11, 14, and 16, near Lake Lagunitas, Marin Co.

2. MARSUPELLA EMARGINATA (Ehrh.) Dumort. Comm. Bot. 114. 1822.

Jungermannia emarginata Ehrh. Beitr. 3: 80. 1788. Hook. Brit. Jung. *pl. 27.* 1816.

Sarcoscyphos Ehrharti Corda; Opiz, Beitr. 652. 1829.*

Nardius emarginatus S. F. Gray, Nat. Arr. Brit. Pl. 1: 694. 1821.

Variable in size and habit, usually stout, loosely or somewhat densely caespitose, green or often yellowish- or reddish-brown, sometimes dark purple: stems commonly erect, .5–8 cm. (mostly 1–4 cm.) high, simple or dichotomously branched, usually destitute of root-hairs except near base and on the numerous basal stolons: leaves rather firm and rigid, transversely inserted, canaliculate-concave or subcomplicate, patent or erecto-patent, mostly approximate, often imbricate toward the apex, quadrate-orbicular, .3–.9 mm. in diameter, from a broad base embracing one half the stem, emarginate or bilobed, the obtuse sinus rarely descending below one fourth the length of the leaf, the lobes broadly ovate, ob-

* See footnote, p. 33.

tuse or rarely acute; leaf-cells oval or round-hexagonal, the median 16–28 μ, the marginal usually a little smaller, all with large trigones: dioicous: antheridia in groups of 2–6, on stalks equaling their vertical diameter or sometimes twice as long, the bracts often with slightly revolute margins: ♀ bracts 2–4 pairs, gradually 2 or 3 times larger than the leaves, very rarely submarginate, the inmost pair highly connate, exserted or immersed, one or two of the exterior pairs sometimes connate at base, lobes similar to those of leaves, median cells 25–34 μ: perianth somewhat shorter than bracts, 4–6-lobed: capsule yellowish-brown, oblong-globose, .54–.7 mm. in length; seta 2–10 mm. long.

On a moist roadside bank near Lake San Andreas, San Mateo Co., Apr. 20, 1895—in company with the foregoing species.

18. GYROTHYRA M. A. Howe, Bull. Torr. Bot. Club, **24**: 201. 1897.

Stem creeping, foliose, subsimple or somewhat sparingly branching, radiculose. Leaves succubous, entire, alternate; underleaves present, free, bifid, segments narrowly lanceolate or subulate; walls of the leaf-cells with triangular thickenings at the angles. Antheridia short-stalked, in the axils of smaller saccate leaves, forming short median or, at first, terminal spikes. ♀ bracts 2–4 pairs (commonly 3 pairs). Perianth terminal, confluent for half its length or more with the bases of the bracts, the greater part of the calyptra, and the tissues of the stem, to form a thick-walled tube (perigynium), with a small bulbous or saccate base; perigynium erect or ascending, making, at maturity, nearly a right angle with the stem. Capsule cylindrical, long-exserted, dehiscing spirally by four very long and slender valves; capsule-valves of two layers of cells, the walls wholly destitute of spiral, semiannular, or other local thickenings. Elaters free, bispiral, acute or bluntly pointed; spores minutely papillate. "Involucellum" of the sporogonium foot well developed.

1. GYROTHYRA UNDERWOODIANA M. A. Howe, *l. c.* 202. *pl. 302, 303.*

Plants rather large, 1–2 cm. long, 2–4 mm. wide, mostly in compact light green tufts: stems creeping, thick, often slightly flattened dorso-ventrally, .5–.65 mm. in diameter, about 15 cells wide in cross section, very densely radiculose, slightly ascending at apex, subsimple or with a few irregularly disposed lateral branches, in female plant innovating from near base of perigynium; root-hairs long, nearly colorless or of a dilute yellowish-brown hue, some-

times tinged proximally with purple, springing in older parts of the stem from oblong or linear dark-purple callosities, made up of the closely coherent root-hair bases and of other ventrally elongated cells; leaves obliquely inserted, linguiform or oval, succubous, rather close, translucent, scarcely decurrent dorsally, often crowded and suberect at stem-apex, marginate, 1.7–4 mm. × 1.4–2 mm., commonly concave below, apex decurved; cells of the margin quadrate or oblong, equaling in size the adjacent or twice as large; other leaf-cells mostly quite regularly pentagonal or hexagonal, 25–70 μ in diameter, oblong and larger towards the base; all with conspicuous trigones: underleaves free, often wine-colored, .6–1 mm. long, bifid ½–⅔ their length into narrowly lanceolate or subulate segments, usually running out into a single series of cells at apex, concealed by the dense mat of root-hairs except in the younger portions of the stem: perigynium tubular, 1–1½ mm. in diameter, and, with the free portion of the perianth, 3–4 mm. long, erect or ascending, nearly at right angles with the stem, tinged with purple ventrally, bulbous or saccate at base; wall of perigynium-tube 5–20 cells in thickness: ♀ bracts 2–4 pairs (commonly 3 pairs), entire or repand, similar in form to the cauline leaves, margins approximate at base dorsally, distant ventrally; uppermost pair inserted at about middle of perianth-tube or, more rarely, at two thirds its height, erect, apex and dorsal margins narrowly reflexed and exposing the perianth, or closely appressed and wholly concealing it; next lower pair usually inserted at about one third height of perianth-tube, more broadly reflexed; the one or two basal pairs but slightly attached to perigynium; bracteoles inconspicuous, sometimes subentire and slightly adherent to base of bracts; bulbus of perigynium without radicles, but a dense tuft of root-hairs springs from the stem just back of the bulbus and long root-hairs come from the cells of the involucral leaves near their bases: perianth free for ⅓–½ its length, free portion nearly echlorophyllose, subtubular, somewhat inflated below, contracted and lax above, crenulate at mouth, 3–5 cells thick at juncture with perigynium-tube, 2 cells thick at mouth: calyptra fleshy, upper third or fourth free at maturity, 3–6 cells in thickness: dioicous: archegonia several, the unfertilized raised on the base of the free portion of calyptra: male plants more slender; antheridia (1–6) in the axils of smaller saccate leaves, forming spikes of 3–6 pairs of leaves decreasing in size upwards, appressed, apices patent or recurved, or, in uppermost pair, erect; antheridia ellipsoidal or pyriform, .15×.24 mm., on pedicels ⅓ as long; slender stems (male?) occasionally gemmiferous at apex, gemmae unicellular, 10–24 μ in diameter: capsule long-cylindrical; valves very slender, 3.3–6 mm. × .13–.17 mm., widely spreading when

dry, attached spiro-radially to a basal disc composed of large hyaline cells, flexuous, contorted, or spiral, when moistened—always with a spiral twist at the apex; foot of sporogonium forming a more or less goblet-shaped "involucellum"; seta 1½–2 cm. long; elaters bispiral, very rarely trispiral, acute or subobtuse, 210–420 μ × 12–15 μ; spores about 12 μ, minutely papillate.

Exsicc. Hep. Am. 184.

Near Eureka, Humboldt Co., June, 1896 (no. 1026); collected also by Prof. John Macoun (herb. Underwood), on earth in a brook, Burrard Inlet, British Columbia, April 6, 1889, and on rocks, British Columbia, April 29, 1889; and by A. A. and E. Gertrude Heller, near Montesano, Chehalis Co., Washington (June 7, 1898, no. 4289).

The leaves of the British Columbia and Washington plants stand with their margins more often erect than in the Californian specimens, upon which our description and figures are based. In the sterile condition, *Gyrothyra* somewhat resembles the larger forms of *Nardia scalaris*—also collected by Macoun on Vancouver Island (Can. Hep. 80)—but can readily be distinguished by the margined, linguiform, more translucent leaves, and by the bifid underleaves.

The ♀ bracts, though more or less apparently paired, are in a strict sense alternate like the cauline leaves, and a single unpaired leaf is sometimes found to occur inside the pair we have described as the uppermost.

It should be remarked that the actual dehiscence of the capsules has not been observed, but the extremely long valves, which on being soaked out take easily a position strongly suggestive of the paring of an apple, the spiro-radial attachment to the basal disc, the never failing spiral twist of the valve-apex, and the spiral lines readily discernible on the surface of the embryo capsule (fig. 10) make, in our judgment, the induction that the dehiscence is spiral so safe and certain that we have felt no hesitation in so describing it and basing the generic name upon this character. The absence of thickenings in the walls of the cells of the capsule valves is noteworthy. Schiffner states* of all the *Jungermanniaceae akrogynae:* "Die reife Kapsel besitzt eine aus 2 bis mehr Zellschichten

* Engler and Prantl, Nat. Pflanzenfam. 1³: 71. 1893.

bestehende Wand, deren Innenschicht in ihren Zellen stets Verdickungsleisten enthält." In *Gyrothyra*, the transverse walls of these cells usually appear a trifle thicker than the longitudinal, but the walls are otherwise wholly without traces of local thickening.

In respect to structure of the sporogonial envelopes, *Gyrothyra* is one of several interesting transitions from the ordinary Jungermannia type to the various pouch-bearing genera. Considered from this point of view and from certain other gametophytic characters, its nearest affinities are undoubtedly to be found in that section of *Nardia* represented by *Nardia haematosticta* (Nees) Lindb., of Europe. In manner of dehiscence of capsule it recalls the marsupiiferous genus *Kantia;* but the valves of *Gyrothyra* are much longer and their cell-walls lack the local thickening, while, of course, no generic comparison of the two is necessary so far as the gametophore is concerned.

PLATES 102 AND 103.

GYROTHYRA UNDERWOODIANA.

1. Entire ♀ plant, × 5.
2. Cauline leaves, × 18.
3. Marginal and adjacent leaf-cells, × 225.
4. Transverse section through marginal portion of leaf, × 216.
5. Underleaves, × 24.
6. Transverse sections of stem, × 22, showing ventral callosity from which the root-hairs arise.
7. Antheridium, × 40.
8. Median sagittal section of perigynium and adjacent portions of stem, showing embryo sporogonium with capsule, seta, foot, and "involucellum," also unfertilized archegonia, perianth, insertion of ♀ bracts, the root-hair callosity, etc., × 23 (slightly schematized). The free part of the perianth as drawn here and in the next is proportionally rather too short and not sufficiently inflated below.
9. Sagittal section of mature perigynium from which the seta has been detached, showing fully developed calyptra and the unfertilized archegonia raised upon the base of its free portion, × 20 (slightly schematized).
10. Surface view of embryo capsule, exhibiting the spiral lines, which presumably bound the valves, × 50.
11. Valves of capsules, showing position taken by them when moistened, × 12.
12. Apex of a single valve, × 12.
13. Base of dehisced capsule from above, showing spiro-radial insertion of valves, × 36.
14. Cells of inner surface of capsule valve, × 150.
15. Elaters and spores, × 137.

19. NARDIA S. F. Gray [as *Nardius*] *p. p.* Nat. Arr. Brit. Pl. 1: 694. 1821.

Mesophylla Dumort. Comm. Bot. 112. 1822.

Alicularia Corda; Opiz, Beitr. 652. 1829.*

Plants medium-sized or small. Stems creeping or ascending, rarely suberect, simple or with a few latero-ventral branches: root-hairs usually long and numerous, often reddish. Leaves alternate, obliquely inserted and succubous or nearly transverse toward the perianth, often vertical-connivent, subreniform to orbicular-ovate, entire or merely repand, rarely retuse at apex, sometimes marginate. Underleaves present, lanceolate or subulate, or (in our species) wanting. Dioicous or paroicous. Androecium in dioicous species terminal or median, ♂ bracts saccate, otherwise similar to the leaves, antheridia mostly in groups of 2–4. Archegonia terminal on the main stem. ♀ bracts 2–5 pairs: in the subgenus *Eunardia*, the superior opposite, connate in pairs, fused with the base of the perianth and the hollowed-out stem-apex to form a perigynial tube, this sometimes ventrally bulbous-thickened, perianth small, rather delicate, included; in the subgenus *Eucalyx*, perianth firm, much exserted, ovoid to obovoid-prismatic, 4–5-carinate and abruptly contracted to a short subtubular mucro at the mouth or carinae wanting and the apex conical and plicate, the superior bracts more or less adnate to perianth (or—more accurately, perhaps—borne on the excavated stem-apex). Calyptra free, surrounded at base by the unfertilized archegonia. Capsule globose-oval, dehiscing by straight rigid valves; cells bounding the inner surface of the valves with numerous semiannular thickenings, those of the outer surface with columnar or nodular thickenings; seta rather short or moderately long. Elaters bispiral.

Both of the species described below belong to the subgenus *Eucalyx*, which passes gradually into the genus *Jungermannia*. *Nardia crenulata*, in which the ♀ bracts are often only very slightly adherent to the base of the perianth, stands on the border line between *Nardia* and *Jungermannia* and would be about equally well at home in either group. *Nardia scalaris* (Schrad.) S. F. Gray, of the subgenus *Eunardia*, has been collected by Professor Macoun on Vancouver Island and may be expected to occur in California. This may be readily distinguished from either of the following species by the presence of lanceolate or subulate underleaves and by the conspicuous trigones of the leaf-cells; the perianth is included within the involucre formed by the bracts and bracteole.

* See footnote, p. 33.

Key to the Species.

Stems 3–8 mm. long, .15–.35 mm. in diameter, root-hairs colorless or yellowish; leaves .4–1.3 mm. long, usually broader than long, margined by enlarged cells or immarginate, slightly or not at all decurrent, median and superior leaf-cells 25–40 μ; ♀ bracts more or less adnate to perianth at its extreme base. 1. *N. crenulata.*

Stems 10–20 mm. long, .27–.64 mm. in diameter, root-hairs reddish-purple (occasionally decolorate); leaves .9–1.7 mm. long, usually longer than broad, mostly patent-horizontal and but slightly overlapping, obscurely if at all margined, decurrent, median and superior leaf-cells 32–60 μ; the inner ♀ bracts adnate to perianth for two thirds its length. 2. *N. obovata.*

1. NARDIA CRENULATA (Sm.) Lindb. Act. Soc. Sci. Fenn. **10**: 529. 1875.

Jungermannia crenulata Sm. Eng. Bot. *pl. 1463.* 1805. Hook. Brit. Jung. *pl. 37.* 1816.

Jungermannia gracillima Sm. Eng. Bot. *pl. 2238.* 1811.

Jungermannia crenulata gracillima Hook. Brit. Jung. *pl. 37.* 1816.

Jungermannia Genthiana Hüben. Hepaticol. Germ. 107. 1834.

Nardia gracillima Lindb. Act. Soc. Sci. Fenn. **10**: 530. 1875.

Nardia crenulata gracillima Lindb. Musc. Scand. 8. 1879.

Jungermannia rubra Gottsche; Underw. Bot. Gaz. **13**: 113. *pl. 4.* 1888. Bolander, Cal. Med. Gaz. 1870: 184 (40) (name only). 1870.

More or less red or brownish-red, very rarely green throughout, gregarious or forming thin compact mats: stems rather slender (.15–.35 mm. in diameter), 3–8 mm. long, prostrate, ascending at apex, simple or often sending out flagelliform latero-ventral branches; root-hairs numerous, moderately long, colorless or slightly yellow: leaves subcartilaginous, obliquely attached, slightly or not at all decurrent; those of the fertile stems usually crowded, subvertical, concave or nearly plane, broadly rounded-ovate or semiorbicular, .4–1.3 mm. long, .54–1.4 wide, entire or repand, in most cases distinctly margined by a single series of enlarged quadrate thick-walled cells, leaves of the sterile stems and flagella commonly distant, smaller, longer than broad, oval or elliptical, patent, often not at all or obscurely marginate; leaf-cells with walls weakly thickened at the angles, the superior and median 25–40 μ, the marginal often 2–3 times as large (in surface area) as the next adjacent; cuticle irregular and minutely hyaline-punctate: underleaves wanting or very rarely present in association with the ♀ bracts: dioicous: androecium terminal, ♂ bracts 3–10 pairs, concave, margined, suberect, imbricate; antheridia usually in pairs, globose,

.16–.2 mm. in diameter, short-stalked, accompanied by a few short paraphyses: ♀ bracts gradually larger than the leaves, more repand and commonly more conspicuously marginate, crowded and suberect or rather loosely disposed and spreading, the uppermost one or two more or less adnate to the base of the perianth or to the perigynial tube formed by the hollowed-out stem-apex, the very rarely occurring bracteole small, obovate, semiorbicular, or linguiform: perianth usually tinged with red or purple, nearly immersed or exserted ½–⅔ its length, subcomplanate-ovoid to narrowly obovoid or prismatic, 1.5–2 mm. long, .8–1.3 mm. in greatest width, nearly always, especially when young, distinctly quadrangular (rarely pentagonal), the angles often incrassate (of two layers of cells), the perianth wall otherwise unistratose except in the basal third or fourth, the mouth at first abruptly contracted into a very short subtubulose mucro, rather obscurely ciliolate-denticulate, at length lacerate: calyptra often reddish or purple, unistratose toward the apex, otherwise bistratose: capsule dark brown, ovoid, .7–.8 mm. in greatest diameter, the wall consisting of two layers of cells; seta 4–10 mm. long; spores brown, 13–16 μ, very minutely granulate; elaters brown, bispiral, attenuate at the extremities, contorted, 80–120 μ long, 8–13 μ in maximum width.

Exsicc. Hep. Am. 200.

On moist, usually exposed banks in the Coast Range Mountains, especially near the sea. Mendocino (Dr. H. N. Bolander); Santa Cruz (W. G. Farlow, May, 1885), Santa Cruz Mountains (L. M. Underwood, August, 1888); near Lake San Andreas, San Mateo Co.; Bolinas, Marin Co. (W. A. Setchell); near Cazadero, Sonoma Co.; Mendocino (582, 591, 620, 682); Eureka (902, 924).

The Californian forms mostly agree with Gottsche's *Jungermannia rubra*, founded on a specimen collected on "metamorphic sandstone, quite near the coast" at Mendocino by Dr. Bolander, but *Jungermannia rubra* seems to us not to differ in any essential structural characters from the European conditions of *Nardia crenulata* which have at times been known as *Jungermannia gracillima* and *J. Genthiana*. Leaves conspicuously margined by cells 2 or 3 times the size of the adjacent occur in the Californian specimens, though rarely. In general, the leaves here are only submarginate. But both Californian and European specimens show such extremes of variation in this particular in different parts of a single tuft or even in different parts of a single plant that this character cannot

be given much weight. The leaves are sometimes slightly more decurrent than we have observed them to be in European forms. The wall of the perianth is often two cells thick at the angles but we have never found the angles externally papillose-serrate.

2. NARDIA OBOVATA (Nees) Lindb. Bot. Notis. 1872: 167. 1872.

Jungermannia obovata Nees, Naturgesch. Eur. Leberm. 1: 332. 1833.

Southbya obovata Lindb. Hartm. Skand. Fl. 2: 130. 1871. [ed. 10.]

Bright green to brownish-red, loosely caespitose: stems rather stout (.27–.64 mm. in diameter), 1–2 cm. long, prostrate or ascending, simple or innovating above in fertile plants, very rarely otherwise branched; root-hairs abundant, long and fasciculate, reddish-purple or occasionally decolorate: leaves rather firm in texture, distant or slightly overlapping, the lower obliquely attached (at an angle of about 45°), patent-horizontal, the upper more transversely inserted, divergent and subsquarrose or somewhat erect, all orbicular-ovate from a narrowed, concave, sheathing base, plane, slightly concave or convex in the upper half, .9–1.7 mm × .7–1.5 mm, dorsally decurrent, entire or subrepand, the apex very obtusely or subtruncately rounded, rarely retuse; leaf-cells thin-walled, usually with small trigones, the sparse or moderately abundant chlorophyll-bodies finally disposed near the vertical (lateral) walls, median and superior cells 32–60 μ, the marginal often subquadrate or a little elongated radially and forming an obscure border, cuticle delicately striatulate-papillate: underleaves none: paroicous: antheridia in pairs, short-stalked, accompanied by a few short paraphyses, borne in the saccate bases of the lower ♀ bracts and adjacent leaves: ♀ bracts 4–6, larger than the leaves, obovate, erecto-patent, commonly reflexed at the apices, the superior 2–4 very highly adnate to the perianth, but not connate: perianth elongate-obovoid, free from the bracts only in the terminal third, the free portion scarcely projecting beyond the uppermost bracts or included, thin, composed of oblong, nearly hyaline cells, plicate toward the subentire or lobate mouth.

On the banks of a shaded slough, Blue Lake, Humboldt Co., June 3, 1896 (1002).

Nardia obovata has not before been recorded, we believe, for America, and as the above specimen is wholly sterile, its reference to this species is open to some question. With the exception of the color of the root-hairs—which show only very rarely a tinge

of reddish-purple—the agreement with European specimens of *Nardia obovata* is, however, so close that at least until more complete material is obtained we can do no better than to identify it with this species. In European specimens the root-hairs are sometimes colorless in certain parts of the stem, though we have never observed in these any such widely extended decoloration as in our Humboldt County plant. In regard to characters of leaves and leaf-cells, the correspondence between the Californian specimen and no. 870*a* of Jack, Leiner, and Stizenberger's Kryptogamen Badens is especially striking. The larger, more ovate, more distant, more patent-horizontal, and occasionally subsquarrose leaves stand in the way of referring the plant to *Nardia hyalina* (Lyell) Carr., while the firmer, subtruncately rounded, occasionally emarginate-retuse, decurrent leaves, and the more distinct trigones seem to preclude the possibility of its being any condition of *Jungermannia riparia* Tayl.

20. JUNGERMANNIA* L. *p. p.* (?) Sp. Pl. 1131. 1753. Ex Rupp. Fl. Jen. 345. 1718. Dumort. *p. p. max.* Rec. d' Obs. Jung. 16. 1835.

Jungermannia § *Aplozia* Dumort. *p. p. max.* Syll. Jung. 47. 1831.

Aplozia Dumort. *p. p. max.* Hep. Eur. 55. 1874.

Liochlaena Nees, G. L. & N. Syn. Hep. 150. 1845.

Jungermannia, subgenus *Eujungermannia* §1, Spruce, Trans. and Proc. Bot. Soc. Edinb. **15**: 508. 1885.

* Professor Schiffner (Eng. & Prantl, Nat. Pflanzenf. 1^3: 82. 1893) has discarded *Jungermannia* altogether as a generic name inasmuch as the *Jungermannia* of modern authors has come to bear little or no resemblance to the group recognized under this name by Linnaeus. *Jungermannia lanceolata* (*Liochlaena lanceolata* Nees) is the only representative of the Linnaean *Jungermannia* species of 1753 to be found in any recent conception of the genus and this same *Jungermannia lanceolata* of Linnaeus—if we are to interpret his species by the synonymy alone—was, according to Lindberg, a mixture of several species none of which was the *Jungermannia lanceolata* as known today, even though one or two of them did belong to the group "*Aplozia*." Dumortier in 1831 divided what was left of *Jungermannia*, after several excisions had been made, into nine sections, two of which were *Aplozia* and *Lophozia*. In 1835 he elevated *Lophozia* to generic rank, retaining the name *Jungermannia* for his former section *Aplozia*. None of the Linnaean specific names appeared under his *Lophozia* and none of the species recognized in the first edition of the Species Plantarum would have naturally found a place in this group. The Linnaean name *Jungermannia lanceolata*,

Plants mostly of medium size. Stems creeping or ascending, less commonly erect, simple or bearing a few latero-ventral branches, sometimes with one or two innovations from below the perianth; root-hairs usually long and moderately abundant. Leaves alternate, obliquely or almost longitudinally inserted and succubous, or transverse throughout, mostly patent-horizontal, rarely semivertical, oblong-elliptical, oblong-ovate, orbicular, or subreniform, never lobed, the margins very entire. Underleaves mostly wanting or small. Paroicous, dioicous, or autoicous. Androecium terminal or median, ♂ bracts ventricose, otherwise similar to the leaves, antheridia mostly 1–3, short-stalked, with or without paraphyses. Archegonia terminal on the main stem. ♀ bracts scarcely different from the leaves, distinct from each other and free from the perianth. Perianth ovoid, cylindrical, or clavate, plicate in the conical upper part or very abruptly contracted to a short tubular mouth, now and then somewhat compressed either laterally or dorso-ventrally. Calyptra free, surrounded at base by the sterile archegonia. Capsule oval or globose, dehiscing by straight valves; cells bounding the inner surface of the valves provided with semi-annular thickenings; seta long or somewhat short. Elaters bispiral.

Key to the Species.

Leaves decurrent.

Leaves very obliquely or almost longitudinally attached, mostly longer than broad. 1. *J. Bolanderi.*

Leaves transversely attached, clasping, mostly broader than long. 3. *J. Danicola.*

Leaves not decurrent, obliquely attached, elliptical-oblong. 2. *J. pumila.*

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which has now come to have a definite meaning, however much it may have covered at the start, was given a place under Dumortier's section *Aplozia*, which four years later became his genus *Jungermannia*. It therefore seems to us that, in the spirit at least of the unwritten "law of residues," the *Aplozia* group is the logical heir to the generic name *Jungermannia*. In 1874, however, Dumortier made an unfortunate and (according to our notions) an unjustifiable transposition of names by which *Jungermannia* was applied to his *Lophozia* of 1835 while his *Jungermannia* of 1835 was rechristened *Aplozia*; in this he has been recently followed by Massalongo, Evans, Heeg, Loitlesberger, and possibly others.

Relying upon a statement by Professor J. B Wilbrand (Flora, 9^2: 518. 1826) to the effect that "Ludovicus Jungerman" never wrote his name Jungerm*ann* but always Jungerm*an*, Lindberg, Spruce, Arnell, Underwood, Schiffner, Pearson, and many others have amended the original spelling of the generic name by omitting one of the n's. But M. Emile Bescherelle states (Journal de Botanique, 7: 191. 1893) that he has been informed by other botanists, among them Herr Stephani, that Jungermann wrote his name with a single *n* or with the two *n*'s. Under these circumstances, we agree with M. Bescherelle that it is better not to interfere with the spelling adopted by Ruppius, Micheli, and Linnaeus.

1. JUNGERMANNIA BOLANDERI Gottsche; Underw. Bot. Gaz. 13: 113. *pl. 5.* 1888.

Pallescent, caespitose: stems 2–3 cm. long, .2–.35 mm. in diameter, prostrate or ascending (?), simple or with infrequent lateral branches, sometimes innovating below the first pair of ♀ bracts; root-hairs nearly obsolete, colorless or very dilutely yellow: leaves hyaline, rather soft, often flexuous or undulate, approximate or slightly succubous-imbricate or on the sterile shoots somewhat distant, very obliquely or almost longitudinally affixed to the stem, patent-horizontal, orbicular-ovate, .8–1.5 mm. long, .7–1.8 mm. wide, usually longer than broad, entire or lightly repand, somewhat concave dorsally with the dorsal margin more or less inflexed, those of the sterile stems nearly plane, all, especially the latter, strongly decurrent; superior leaf-cells 25–40 μ, the marginal not differentiated, the basal 45–96 μ, the thin walls scarcely or not at all thickened at the angles, cuticle smooth or slightly roughened: dioicous (?): ♀ bracts one or two pairs, wholly free from the perianth, the uppermost twice as large as the leaves, more concave, and more transversely inserted, otherwise similar: perianth cylindrical-obovoid, abruptly contracted when young to a small subentire or slightly denticulate subrostellate mouth, exhibiting finally 3–5 obtuse irregular folds in the superior half: antheridia and sporogonia unknown.

In ditches, Mt. Dana, altitude about 3100 meters (Dr. H. N. Bolander, September, 1866).

Jungermannia Bolanderi is evidently allied to *Jungermannia riparia* Tayl. and *J. pumila* With., yet is sufficiently distinct from either in the nearly rootless stems, the softer, strongly decurrent, almost longitudinally affixed leaves, and in the larger leaf-cells, of which the marginal show no (or extremely slight) tendency to be smaller than their neighbors and quadrate. The leaves are usually broadest below the middle, while in *Jungermannia pumila* they are usually broadest at just about the middle. Of perianths we have seen but two and these were apparently enclosing unfertilized archegonia and were thus probably not fully and perfectly developed. The larger of these was 1.4 mm. long and .8 mm. in greatest width, which was about the size of those seen by Dr. Gottsche, judging from his figures and his scale of magnification. The mouth in this was smaller, more nearly entire, and more abruptly contracted than in either *Jungermannia riparia* or *J. pumila* —was, in fact, almost liochlaenoid. Our description of the peri-

anth has been drawn in part from Gottsche's figures. Sterile plants bear some resemblance to *Nardia obovata* but differ in the almost entire absence of root-hairs, the softer, more decurrent, and much more longitudinally affixed leaves.

A type duplicate of *Jungermannia Bolanderi* from the hand of Dr. Gottsche, together with his original pencil sketches of the species, is preserved in the herbarium of Harvard University, which is true also of Dr. Gottsche's *Jungermannia Danicola*, *J. Müller Danaensis*, and *J. rubra*. We have made an effort to see the remainder of Dr. Gottsche's material of this and of his other Californian species, but without success. Dr. Gottsche's herbarium is in the possession of the Royal Botanical Museum at Berlin, but Dr. Hennings, in response to our inquiries, writes that the Gottsche collection is only partly arranged and that the Californian specimens desired cannot thus far be found.

2. JUNGERMANNIA PUMILA With. Arr. Brit. Pl. **3**: 866. *pl. 18. f. 4.* 1796. [ed. 3.]*

Dark green, sometimes brownish or blackening, forming thin, loosely or closely interwoven mats: stems creeping, commonly ascending at apex, simple or sparingly branched, rhizomatous from the ventral surface or now and then innovating from the axils of the bracts; root-hairs usually long and numerous, colorless or yellowish-brown: the lower leaves loosely disposed, scarcely contiguous, obliquely affixed (line of attachment making an angle of about 45° with stem), patent-horizontal, less commonly semivertical, the upper closer, more transversely attached and more erect, all elliptical-oblong, .36–.9 × .27–.8 mm., obtuse, somewhat concave or nearly plane, entire or slightly repand, not decurrent; leaf-cells transparent, thin-walled, scarcely or not at all thickened at the angles, the median 18–35 μ, only a little enlarged toward the base, the marginal slightly smaller and subquadrate; cuticle finely striatulate or punctulate: underleaves none: paroicous: antheridia spherical, short-stalked, occurring singly in the axils of 2–4 pairs of saccate, clasping, suberect, more or less enlarged leaves, these functioning also as ♀ bracts: perianth narrowly cylindrical-obovoid, 1.2–2.5 × .36–1 mm., somewhat plicate in the terminal half or third and rather gradually narrowed to a small slightly hyaline-denticulate mouth.

On moist rocks, stones in brooks, etc.

* We have been unable to see the third edition of Withering's work.

The occurrence in California of this widely distributed species cannot be considered as demonstrated beyond the possibility of a doubt. It is inserted here on the strength of the existence in Professor Underwood's collection of a specimen from the Roy Herbarium labeled "Bolander, Sept., 1866," without indication of locality. From such an inscription it is natural to infer that Bolander was the collector. Dr. Bolander was upon Mt. Dana early in September, 1866, and according to his journal, for an extract from which we are indebted to Dr. W. L. Jepson, seems to have spent the remainder of the month in San Francisco. Another specimen, however, from the Roy Herbarium, so identical with the former even in its algal associates as to make it practically certain that the two grew in the same tuft, is labeled "Near McLeod's Lake, B. C., J. Macoun, 26 June, 1875." A similar plant, though apparently dioicous and having larger, more ovate leaves, has been collected since that date by Professor Macoun in several localities in British Columbia.

3. JUNGERMANNIA DANICOLA Gottsche; Underw. Bot. Gaz. **13**: 113. *pl. 3.* 1888.

Fuscous-brown, caespitose: stems prostrate-entangled, 6–10 mm. long, .18–.36 mm. (in attenuate conditions only .08–.1 mm.) in diameter, simple, sparingly dichotomous, or emitting a few lateral branches, sometimes innovating from near the base of perianth; root-hairs very long, colorless or tawny, commonly wanting toward the stem-apex and on the more slender stems and innovations, otherwise moderately abundant: leaves somewhat distant or contiguous, slightly overlapping and a little larger toward apex of stem, patent or patent-horizontal, transversely inserted, concave, embracing more than one half the stem, decurrent, entire, those of the fertile stems broadly orbicular to subreniform, .5–.9 mm. long, .65–1.2 mm. wide, those of the attenuate sterile stems smaller, orbicular or broadly ovate; superior and median leaf-cells 24–50 μ, the walls with small trigonal thickenings at the angles, chloroplasts and oil bodies rather few, the marginal cells slightly smaller but scarcely differentiated in form or color, cuticle nearly smooth or sometimes very minutely hyaline-papillate: underleaves none: monoicous (paroicous ?): antheridia in pairs, short-stalked, in the axils of hardly modified stem-leaves somewhat removed from the ♀ bracts, which are similar to the leaves though more erect: perianth finally obovoid, exserted, irregularly plicate toward the some-

what abruptly contracted, at first crenulate-denticulate mouth: sporogonium unknown.

In ditches, Mt. Dana, alt. about 3100 m. (Dr. Henry N. Bolander, September, 1866).

Jungermannia Danicola is very closely allied to the *Jungermannia amplexicaulis* Dumort. (*J. tersa* Nees) of Europe. It differs, however, in several more or less significant particulars and had best be considered distinct, at least until better known. We have been unable to find either perianth or antheridia in that portion of the type material preserved in the Gray Herbarium, and have drawn our brief description of these parts from Dr. Gottsche's figures. What we have seen of the original material consists mostly of slender and distant-leaved sterile shoots; these, judging from the stouter stems which sometimes occur and which Dr. Gottsche sketched, probably do not fairly represent the species. From *Jungermannia amplexicaulis*, the Mt. Dana plant seems to differ in the dark brown color, the smaller size, the apparently prostrate (possibly ascending) stems, the smaller rather more distant, more translucent leaves, and the less differentiated marginal cells. The two antheridia figured by Dr. Gottsche occupy the axil of the fourth leaf below the perianth, counting on one side only. *Jungermannia amplexicaulis* (*J. tersa*) is described by Nees, Limpricht, and Stephani as dioicous, but Lindberg (Kongl. Sv. Vet. Akad. Handl. 23^5: 39. 1889) states that it is paroicous. As represented in Jack, Leiner, and Stizenberger, Kryptogamen Badens, no. 873 *b* and *c*, the species is certainly paroicous, it being not difficult to demonstrate collapsed antheridia with their still persistent stalks, intermingled with a few paraphyses of various forms, in the slightly saccate bases of the ♀ bracts. In Gottsche and Rabenhorst, Hep. Eur. nos. 359 and 511, we find paraphyses in the axils of the ♀ bracts, but detect no unquestionable antheridial remains. The occurrence of antheridia in the position figured by Gottsche in *Jungermannia Danicola* suggests the possibility that they may occur also nearer the archegonia.

The perianth of *Jungermannia amplexicaulis* is when young rather abruptly contracted at the apex to form a small subtubulose mouth. Dr. Gottsche's figure of a very young perianth of *J. Danicola* shows no appreciable contraction but it would appear that this

surrounds immature archegonia, when the contraction would naturally be less than at a little later period in the development of the perianth; however, we suspect that there may be some difference in this regard between *Jungermannia Danicola* and *J. amplexicaulis*.

From *Jungermannia sphaerocarpa* Hook. (including *J. lurida* Dumort. and *J. nana* Nees), *Jungermannia Danicola* appears to be distinct in the transversely inserted, proportionally broader, more concave, more clasping, and more spreading leaves.

21. LOPHOZIA Dumort. *p. p. max.* Rec. d'Obs. Jung. 17. 1835. Schiffn.; Engler & Prantl, Nat. Pflanzenfam. I[3]: 84. 1893.

Gymnocolea Dumort. *p. p., l. c.*

Diplophyllum Dumort. *p. p., l. c.*, 15.

Jungermannia § *Lophozia* Dumort. *p. p. max.* Syll. Jung. 53. 1831.

Jungermannia Dumort. Hep. Eur. 68. 1874. And of nearly all authors.

Plants small to very robust. Stems creeping or ascending, simple, dichotomous, or with a few latero-ventral branches, often innovating from near the base of the perianth; root-hairs usually numerous. Leaves alternate, succubous, or transversely inserted, with 2–5 (commonly acute) teeth or lobes, plane or more often dorsally concave, sometimes complicate-bilobed but never acutely carinate; walls of the leaf-cells thin or with trigones at the angles, never pitted or nodulose. Underleaves wanting or when present mostly small, lanceolate-subulate and entire, or bifid, or ciliate-fringed. Androecium terminal or median; ♂ bracts sometimes with an additional tooth or lobe on the dorsal margin near the ventricose base, antheridia 1–9 (commonly 1–3), mostly short-stalked, with or without paraphyses. Archegonia terminal on the main stem. ♀ bracts distinct, free, usually somewhat different from the leaves, often with more lobes, and sometimes dentate-margined. Perianth oval, cylindrical, or cylindric-obovoid, plicate above the middle or sometimes only obscurely at the very mouth, the apex obtuse, or more commonly conical, or in some species abruptly contracted to a small tubulose mucro at the mouth. Calyptra free. Capsule subglobose to elongate-ovoid, dehiscing by four straight rigid valves, these usually composed of three layers of cells, the inner with semiannular thickenings. Elaters bispiral.

Key to the Species.

Underleaves present (usually inconspicuous). 3. *L. heterocolpa.*

Underleaves wanting (unless in association with ♀ bracts).

Leaves bilobed to below the middle, complicate, transversely inserted; the dorsal lobe lanceolate, suberect or ascending; the ventral lobe ovate or oblong-ovate, patent-horizontal. 5. *L. ovata.*

Lobing or cleavage of the leaves not extending below the middle.

Leaves unequally 2–5-lobed ⅓–½ their length, the lobes acutely and in most cases spinescently pointed, the margins more or less spinulose-dentate; median leaf-cells 30–60 μ. 1. *L. incisa.*

Leaves 2- (rarely 3-) lobed ⅕–⅔ their length, close or approximate, the lobes acute, occasionally apiculate, rarely subobtuse, entire, the sinus broad; median leaf-cells 24–32 μ. 2. *L. ventricosa.*

Leaves 2-lobed ¼–⅓ their length, usually distant or merely approximate, the lobes obtuse, entire, the sinus rather narrow. 4. *L. inflata.*

1. LOPHOZIA INCISA (Schrad.) Dumort. Rec. d'Obs. Jung. 17. 1835.

Jungermannia incisa Schrad. Syst. Samml. Krypt. Gew. **2**: 5. 1797. Schrad. Jour. Bot. 1801: 67. 1803. Hook. Brit. Jung. *pl. 10.* 1816.

Light green or darkening, densely and intricately caespitose or widely depressed-gregarious: stems very short and thick (4–6 mm. × .27–1.1 mm.), ascending, simple, once furcate, or sending out one or two lateral branches toward the apex; root-hairs numerous, long, colorless: leaves usually close, commonly crowded at stem-apex, plicate-crispate, succulent, almost transversely inserted or somewhat oblique and succubous, subcomplicate, erecto-patent, subquadrate or ovate-oblong, .7–1.8 mm. × .5–1.7 mm., deeply (⅓–½) and unequally 2–5-lobed, the lobes triangular-ovate, acutely and in most cases spinescently pointed, their margins usually reflexed and, especially in the larger ventral lobes, more or less spinulose-dentate, sinuses acute or rounded; leaf-cells quadrate-hexagonal, becoming oblong toward the base, the median 30–60 μ, thin-walled, with rather small though distinct trigones, the abundant chloroplasts and small oil-bodies usually aggregated near the middle of the cell, cuticle smooth; gemmae frequent, mostly in clusters at the tips of the leaf-lobes, irregularly tetrahedral or cubico-sphaeroidal, uniseptate: lanceolate or subulate underleaves sometimes present in association with the ♀ bracts, otherwise wholly wanting: dioicous: ♂ bracts closely crowded together toward stem-apex, scarcely different from the ordinary leaves; antheridia single or in pairs, subglobose, .18–.2 mm. in diameter, on very short pedicels, paraphyses none: ♀ bracts a little larger than the leaves, broader than long, deeply 3–5-cleft, more abundantly dentate and more

strongly crisped: perianth oval to elongate-obovoid, 2–3.5 mm. × .9–1.5 mm., bistratose at base, the plicate mouth ciliate-dentate: seta 5–12 mm. long; capsule subglobose, reddish-brown, .7–1 mm. in diameter, the valves thick and rigid, of three layers of cells, the walls of the cells of the inner layers provided with very numerous annular or semiannular thickenings, those of the external layer with similar but much less perfect fibers; spores cinnamon-brown, 13–15 μ, minutely granulate-papillate; elaters fusiform, 80–145 μ long, 8–10 μ in greatest width, somewhat geniculate.

On logs or decaying wood in moist places. Sisson, Siskiyou Co. (40, 41); near Mendocino (672); near Eureka (962).

All our Californian specimens with the exception of no. 41 are sterile and gemmiferous, with the leaves mostly 2-, less commonly 3-lobed, otherwise subentire, the lobes, with rare exceptions, merely acute. Our no. 40, with leaves of this character, was once (Erythea, **4**: 49. 1896) erroneously referred to *Jungermannia ventricosa* Dicks., from which it may be readily distinguished by the more deeply and unequally lobed and more complicate leaves, the smaller dorsal lobe being often inclined forward somewhat parallel to the stem, and by the larger, thinner-walled leaf-cells.

Our description of the sporogonium has been drawn from a Montana specimen collected by Mr. R. S. Williams and from European material.

2. LOPHOZIA VENTRICOSA (Dicks.) Dumort. Rec. d'Obs. Jung. 17. 1835.

Jungermannia ventricosa Dicks. Pl. Crypt. **2**: 14. 1790. Hook. Brit. Jung. *pl. 28.* 1816.

Jungermannia porphyroleuca Nees, Naturgesch. Eur. Leberm. **2**: 78. 1836.

Yellowish-green, sometimes reddish-brown or subfuscous, densely caespitose: stems .5–1.5 cm. long, prostrate or ascending, sparingly branched, often reddish underneath, the numerous root-hairs mostly colorless and rather short: leaves close or approximate, obliquely inserted or almost transverse toward the apex, semivertical or spreading, slightly concave, now and then (especially the superior) canaliculate or obtusely subcomplicate, often soft and somewhat flaccid, ovate-quadrate, 2- (rarely 3-) lobed, the sinus broad, mostly rounded-obtuse, occasionally gibbous, descending $\frac{1}{5}$–$\frac{2}{5}$ the length of the leaf, lobes acute, occasionally apiculate, rarely subobtuse, often erose through the formation of gemmae,

these marginal or more commonly in clusters at the apices of the lobes, irregular, somewhat tetrahedral or subcubical, mostly uniseptate; median leaf-cells rounded-hexagonal, 24–32 μ, trigones distinct but variable in size, the cuticle smooth or slightly roughened: subulate or broader and bifid underleaves usually present in association with the ♀ bracts and sometimes on young "subfloral" innovations, otherwise wholly wanting: dioicous: androecia terminal, oval; ♂ bracts imbricate, transversely inserted, obtusely subcomplicate, ventricose; antheridia in pairs or single, oval, .12–.18 mm. in greatest diameter, on short stalks composed of a single row of cells, accompanied by a few short paraphyses: ♀ bracts somewhat larger than the leaves, the inmost deeply and unequally 2–5- (mostly 3- or 4-) lobed, often slightly plicate, the lobes acute or subobtuse: perianth cylindrical-obovoid, 2–3 mm. long, 1–1.5 mm. in greatest width, unistratose except at extreme base, the plicate mouth ciliolate-denticulate: calyptra mostly bistratose: seta 10–15 mm. long; capsule-valves purplish- or yellowish-brown, .9–1.1 mm. long, of three layers of cells, the inner with close annular or semiannular fibers, the outer with nodular or imperfect semiannular thickenings; spores yellowish- or reddish-brown, finely granulate-papillate, 12–14 μ; elaters fusiform, subobtuse, 80–130 μ × 8–10 μ.

On soil in moist places and on decaying wood. Mt. Dana at about 3100 m. alt., associated with *Lophozia heterocolpa*, *Jungermannia Danicola*, and *J. Bolanderi* (Dr. H. N. Bolander, September, 1866); between Farewell Gap and Mineral King, Tulare Co., alt. 3500 m. (Coville and Funston, Death Valley Expedition, no. 1573, Aug. 10, 1891); beside "Horse Camp Spring," above timberline, Mt. Shasta, alt. (est.) about 3100 m. (Howe, August, 1894).

These three high-altitude specimens, the second ♂ and the others sterile, seem clearly to fall in the form-cycle of *Lophozia ventricosa*, agreeing essentially with the soft-leaved terricolous conditions of this species from other parts of the world, as represented, for example, in Carr. and Pears. Brit. Hep. no. 171. The plants grow in densely compacted tufts, and the walls of the leaf-cells, in the last two specimens especially, are but slightly thickened at the angles save in the more exposed parts. Lindberg and Arnell (Kongl. Sv. Vet. Akad. Handl. **23**[5]: 50. 1889) would restrict the application of the specific name *ventricosa* to forms with poorly developed trigones, but Lindenberg (Syn. Hep. Eur. 86. 1829), who, it would appear, had examined original Dicksonian speci-

mens, affirms that these agree with his form *conferta* characterized partly by a "*textura firma*," instead of the "*contextu laxiore*" of the form *laxa*, which possibly indicates that the form with well developed trigones should be considered typical.

The leaves of the Mt. Shasta plant have a rather unusually pronounced tendency toward being complicate, but this feature is observable now and then in specimens from other localities. The form or variety inhabiting chiefly decaying logs and stumps (*J. porphyroleuca* Nees) is to be expected to occur in California, particularly, perhaps, in the northern coast counties.

We have observed in North American specimens of *Lophozia ventricosa* the two kinds of coloration of the capsule noted by Limpricht (Cohn, Krypt.-Fl. Schles. 1: 280, 281. 1877), but cannot determine that this character stands in any constant relation to other characters which have been supposed by some to distinguish *Jungermannia porphyroleuca* from *J. ventricosa*. In Austin's Hep. Bor.-Am. no. 36, for instance, the purplish-brown or "violet-red-brown" capsules occur on gametophytes which exhibit leaf-cells with the strongly developed trigones and roughened cuticle supposedly characteristic of *J. porphyroleuca*.

It is extremely doubtful if the original of *Jungermannia ventricosa* exists in Dickson's Herbarium in the British Museum. Two scraps are, however, to be found there, under which is written, in pencil, in what is said to be Dickson's hand,

"bid^ta With. ed. 3
ventricosa"

But these belong to the genus *Lophocolea*. The leaves of these, with the exception of the younger, are considerably *less* deeply cleft than those in the figures of Micheli and Dillenius which Dickson cites, and in allusion to which he remarks: "Folia in nostra profundius fissa, quam in figuris Michelii et Dillenii depinguntur." A young trigonous-prismatic perianth, twice as long as broad—which Dickson probably could not have described by "*vagina sphaeroidea*"—is present on one of the scraps. The reference to the third edition of Withering would indicate that the inscription under these specimens was written at least six years after the original publication of *Jungermannia ventricosa*.

3. LOPHOZIA HETEROCOLPA (Thed.)

Jungermannia heterocolpa Thed. Kongl. Sv. Vet. Acad. Handl. 1838: 52, 72. *pl. 1.* 1839. [As *J. heterocolpos.*]

Jungermannia Mülleri heterocolpos G. L. & N. Syn. Hep. 99. 1844.

Jungermannia Wattiana Aust. Bull. Torr. Bot. Club, **3**: 11. 1872.

Jungermannia Mülleri Danaensis Gottsche; Underw. Bot. Gaz. **13**: 114. *pl. 6.* 1888.

Yellowish- or lurid-green, densely caespitose or creeping among mosses: stems 6–15 mm. long, .12–.3 mm. thick, prostrate or ascending, sparingly ramose, the ♀ commonly continued through the development of an innovation from underneath the perianth, the median innovation sometimes accompanied by one or two lateral; root-hairs numerous, long, colorless: leaves close or approximate, obliquely inserted, patent or sometimes subvertical toward the stem-apex, usually firm in texture, rarely somewhat soft and flaccid, not decurrent, orbicular-ovate or subquadrate-elliptical, .36–1 mm. × .35–.8 mm., the superior usually somewhat concave dorsally, the inferior more or less arcuate-convex, all emarginate-bilobed $\frac{1}{6}$–$\frac{1}{3}$ their length, the acute or obtuse sinus commonly gibbous-recurved, the lobes obtuse, rarely subtriangular-acutate, those of the inferior leaves often slightly arcuate-recurved; marginal and superior leaf-cells 16–32 μ (mostly 20–25 μ), trigones well developed (6–11 μ), the cuticle with very obscure hyaline roughenings: underleaves small, lanceolate-subulate and subentire or bifid and sometimes sparingly dentate at base: gemmae frequent, brown, subglobose-ellipsoidal, uniseptate, 24–30 μ × 16–24 μ, borne on the apices of much modified, larger-celled, 3-ranked leaves, these erect-imbricate in a more or less elongated terminal spike: dioicous: ♂ bracts unidentate on dorsal margin; antheridia paired, on very short stalks: ♀ bracts gradually a little larger than the leaves and sometimes with repand margins, otherwise similar: perianth ovoid to obovoid-oblong, 1.5–2 mm. × .9–1.2 mm., often apparently dorsal owing to the early development of a strong hypogynous innovation, somewhat laterally compressed in the upper half when young, the small mouth minutely denticulate.

In ditches, Mt. Dana, alt. about 3100 m. (Dr. H. N. Bolander, September, 1866); Fish Creek, Mariposa Co. (Miss Edith S. Byxbee, July, 1895).

In the description of *Jungermannia Mülleri Danaensis* (*l. c.*), it

is stated that "amphigastria" are wanting, but an examination of the specimen sent by Dr. Gottsche to the Gray Herbarium discloses underleaves of the *J. Mülleri-heterocolpa* type more or less concealed by the root-hairs, and Dr. Gottsche had evidently intended to represent these in his camera-lucida tracings, especially in the figures published by Professor Underwood (*l. c.*) under Nos. V., IX., X., XII., and XV. The leaf-cells of the Mt. Dana material are mostly less strongly collenchymatous than those of Scandinavian specimens of *Lophozia heterocolpa* that we have examined, yet portions of this same material show all the transitions to trigones of the normal size. The plant collected by Miss Byxbee has larger leaf-cells, together with larger trigones, and in this respect makes an approach to *Jungermannia Mülleri* Nees, but differs from that species in the usually obtuse leaf-lobes, in the ♀ bracts being entire (except for the median cleft) or merely repand, in the ovoid or obovoid-oblong perianth, which is not at all rostellate, and in the presence of transformed spicate gemmiparous leaves. The perianths in this specimen are nearly all falsely dorsal. In the original diagnosis of *Jungermannia heterocolpa*, Thedenius writes "*fructu terminali* (*rarius pseudoalari*)" and his figure shows a terminal perianth. We have seen but one European perianth-bearing specimen of *J. heterocolpa*, which we owe to the kindness of Dr. H. W. Arnell; in this about one fourth of the perianths have become falsely dorsal or lateral. In this, too, the perianths have only about two thirds of the length assigned to the perianths of the species of Lindberg (Kongl. Sv. Vet. Akad. Handl. **23**[5]: 43. 1889), agreeing closely in this respect with the American forms.

Inasmuch as Limpricht (Cohn, Krypt.-Fl. Schles. **1**: 276. 1877) has remarked that an apparent original of *Jungermannia Bantriensis* Hook. (found in Herb. v. Flotow, with the legend, "J. bantriensis N. v. E. Irland, Herb. Hook.! dd. N. ab. E.") is the gemmiferous ♂ plant of *Jungermannia Mülleri* and as Lindberg (Kongl. Sv. Vet. Akad. Handl. **23**[5]: 43. 1889) has observed that the gemmiparous forms of *J. Mülleri* of authors ought probably to be referred to *J. heterocolpa*, we have made an effort to examine the Hookerian material of *J. Bantriensis*. In response to an inquiry addressed to Sir W. T. Thiselton-Dyer, as to whether

the original specimen of Hooker's *Jungermannia Bantriensis*, collected by Miss Hutchins at Bantry, Ireland, was still preserved at Kew, we received the following statement: "There is no specimen of this at Kew marked, 'Bantry, Miss Hutchins.' But on a specimen not localized is written (I believe in Wilson's handwriting): 'This is probably the specimen mentioned in Brit. Jung^{ae}. See note to description of *J. stipulacea*.' The note referred to contains the diagnosis of *J. Bantriensis*. A portion of this specimen is enclosed." This specimen proves to be *Harpanthus Flotovianus* Nees. It is readily distinguishable from any of the *Lophozia Mülleri-heterocolpa* alliance by the decurrent leaves, the wholly smooth cuticle, the larger underleaves, and the short ventral ♀ branches, which here bear unfertilized archegonia; some of the stems are gemmiparous at the apex, but the gemmiparous leaves are not transformed in any such way as in *Lophozia heterocolpa*. A comparison of this specimen with Hooker's figure and description precludes the possibility of its being the desired original.

To the friendly generosity of Mr. W. H. Pearson, we owe the privilege of examining a specimen marked "Jung. Bantriensis Hook. Bantry. Coll. Miss Hutchins, Nov. 19, 1812. *Original.*" This specimen, though sterile, we can easily believe to have been a part of the original material studied by Hooker. It agrees essentially with *Jungermannia Hornschuchiana* Nees as represented in Rab. Hep. Eur. 128, differing chiefly in the slightly smaller leaf-cells and the more prominently verruculose-striolate or granulate-papillate cuticle. From *Lophozia heterocolpa* it differs in the larger (about 1.5 mm. wide) flaccid decurrent leaves, which are bidentate rather than bilobed, the usually acute teeth being separated by a broad, shallow sinus, in the larger leaf-cells (marginal and superior 28–50 μ), in the very distinctly roughened cuticle, and in the absence of gemmae.

4. LOPHOZIA INFLATA (Huds.)

Jungermannia inflata Huds. Fl. Angl. 511. 1778 [ed. 2].
Gymnocolea inflata Dumort. Rec. d'Obs. Jung. 17. 1835.

Green, yellowish-brown, or sometimes blackening, with (especially in the darker forms) a somewhat oleaginous lustre, usually forming soft closely interwoven mats: stems prostrate, ascending, or occasionally erect, 6–20 mm. long, .09–.25 mm. in diameter,

mostly weak and slender, sparingly subdichotomous, or with a few lateral or latero-ventral branches, often innovating from near the base of the perianth ; root-hairs short, scanty, colorless or yellowish : leaves usually distant or contiguous, obliquely inserted, patent-horizontal to erecto-patent, now and then reflexed, orbicular-ovate to subquadrate-oblong, .36–.9 mm. × .27–.8 mm., somewhat decurrent dorsally, concave or nearly plane, bilobed ¼–⅓ their length, the sinus rather narrow, more or less obtuse, the margin otherwise entire or slightly repand, lobes obtuse, nearly parallel, rarely inclined toward each other or subdivergent, the dorsal a little the smaller; leaf-cells rather thick-walled, with indistinct trigones, the superior and median 24–40 μ, the basal scarcely larger, cuticle smooth or obscurely striolate : underleaves wanting unless in association with the ♀ bracts : dioicous : androecium terminal or median, ♂ bracts imbricate, concave, mostly broader than long, almost transversely inserted ; antheridia ovoid, .2 mm. in greatest diameter, on very short stalks, unaccompanied by paraphyses : ♀ bracts often a little smaller than the leaves, otherwise similar : perianth much exserted, sometimes exposed to the extreme base or even appearing stipitate, now and then falsely dorsal through the development of a "subfloral" innovation, prolate-ellipsoidal or elongate-pyriform, 2–2.7 mm. × .85–1.2 mm., inflated, smooth throughout or obscurely plicate only at the obtuse apex, the wall bistratose in the basal third or fourth, the mouth with a few short connivent teeth : capsule elongate-ovoid, its wall of three layers of cells, the external layer with nodular or columnar thickenings, the others with semiannular ; spores 14–18 μ, granulate-papillate, elaters contorted, slightly attenuate at extremities, 120–180 μ long, 8–10 μ in maximum width.

In swamps, on wet rocks, etc.

"Mt. Dana, Cal., legit H. N. Bolander" in herb. Underwood. The specimen is wholly sterile, but we feel no doubt as to its identity with the above species.

5. LOPHOZIA OVATA (Dicks.)

Jungermannia ovata Dicks. Pl. Crypt. Brit. **3**: 11. *pl. 8. f. 6.* 1793.

Jungermannia Dicksoni Hook. Brit. Jung. *pl. 48.* 1816.

Diplophyllum Dicksoni Dumort. Rec. d'Obs. Jung. 16. 1835.

Diplophylleia Dicksoni Trevis. Mem. r. Ist. Lomb. III. **4**: 420. 1877.

Bright green above, darker below, caespitose, often in compact extended mats ; stems 8–20 mm. long, simple or dichotomously

branched, prostrate-entangled or slightly ascending, rather rigid, beset with long root-hairs almost to the apex: leaves transversely inserted, of nearly uniform size throughout, .5–.9 mm. long, not decurrent, bilobed to below the middle ($\frac{3}{5}$–$\frac{2}{3}$) with an acute sinus, complicate, the fold nearly a right angle but rounded; lobes of about equal length, acuminate, obscurely crenulate towards the apex, the dorsal narrower, lanceolate, suberect or ascending, somewhat parallel to the stem, the ventral ovate or oblong-ovate, patent-horizontal (75°–80°), submarginate toward the base; leaf-cells opaque, firm-walled, with small trigones, hexagonal-quadrate, 17–24 μ, more elongated at base, cuticle minutely roughened: underleaves none: antheridia 1 or 2, subglobose, without paraphyses, on short pedicels in the axils of closer somewhat ventricose leaves with appressed imbricate dorsal lobes: ♀ bracts larger than the leaves, long-acuminate, sparingly dentate; perianth oval or oblong, 2–3 times length of the involucral leaves, deeply plicate, the mouth ciliate-lacinulate.

Exsicc. Hep. Am. 193 (as *Diplophylleia Dicksoni*).

On the face of a shaded cliff near Cazadero, Sonoma Co., on the road to Fort Ross (Mar. 14, 1896). Collected also by Dr. Bolander at Mendocino City. These are the only American stations thus far known for this hepatic. Our specimens are sterile or bear antheridia alone, so that the species is presumably dioicous. The description of involucre and perianth is drawn from Husnot's Hep. Gall. no. 29. The leaves are rarely three-lobed in the Californian plants as also in the European.

The identification of Dickson's *Jungermannia ovata "e specimine auctoris"* was first made by Lindberg (Musc. Scand. 7. 1879). Mr. A. Gepp of the British Museum has kindly at our request examined the specimen of *J. ovata* Dicks. in the Dickson herbarium and confirms the determination of Lindberg. Mr. Gepp writes: "Our specimen of *J. ovata* Dicks. is labeled *ovata* by Dickson, and, so far as the arrangement of the specimens goes, it is the undoubted type of the species."

The rounded, instead of acutely carinate, fold of the leaf sufficiently removes the species from the genus *Diplophylleia* and places it in the *Sphenolobus* section of *Lophozia*.

22. PLAGIOCHILA Dumort. Rec. d'Obs. Jung. 14. 1835.

Martinellius S. F. Gray *p. p.* Nat. Arr. Brit. Pl. 1: 690. 1821.

Radula Dumort. *p. p.* Comm. Bot. 112. 1822.

Radula § *Plagiochila* Dumort. *p. p.* Syll. Jung. 42. 1831.

Plants usually large. The primary stems creeping, radiculose, nearly leafless, rhizome-like; secondary stems foliose, commonly ascending or suberect, stout, rufous or dark-brown, rarely pallid, mostly destitute of root-hairs, simple or dichotomously branched, less commonly pinnate, often subdendroid. Leaves large, succubous, in most species alternate, plano-distichous or deflexed, sometimes secund, decurrent dorsally and more or less ventrally, unsymmetrical; the apex mostly rounded or truncate, dentate or spinose, rarely entire; the dorsal margin nearly straight or slightly concave, recurved, especially toward the base, in most cases subentire; ventral margin arcuate, plane or decurved at the base, dentate or spinose, very rarely entire; leaf-cells generally medium-sized or rather large, with distinct trigones. Underleaves wanting or occurring only toward the stem-apex or sometimes present throughout, small or minute, entire or irregularly bi–multi-fid. Androecium spicate, terminal or median; ♂ bracts smaller than the leaves, transversely inserted, closely imbricate, their bases erect, ventricose-saccate, the basal margins highly adnate to the stem; antheridia 1–10. Archegonia very numerous, terminal on the main (secondary) stem or the branches. ♀ bracts distinct, free, usually differing but little from the leaves, somewhat larger and more strongly toothed. Perianth exserted, strongly compressed laterally (at least when young), with a more or less winged suture dorsally and sometimes also ventrally, campanulate or obconic-cylindrical, the wide mouth usually obliquely truncate, often bilabiate, the lips dentate-spinose or ciliate-fringed. Calyptra free, included. Capsule globose-oval, dehiscing to the base by four straight sometimes bifid valves, these composed of several layers of cells, cells bounding the inner surface provided with numerous semiannular bands; seta rarely more than twice the length of the perianth. Elaters bispiral.

1. PLAGIOCHILA ASPLENIOIDES (L.) Dumort. Rec. d'Obs. Jung. 14. 1835. Lindenb. Spec. Hep. (*Plagiochila*), 110. *pl. 23.* 1839 (?).

Jungermannia asplenioides L. Sp. Pl. 1131. 1753. Hook. Brit. Jung. *pl. 13.* 1816.

Jungermannia porelloides Torrey; Nees, Naturgesch. Eur. Leberm. 1: 169. 1833.

Plagiochila porelloides Lindenb. Spec. Hep. (*Plagiochila*), 61. *pl. 12.* 1839 (?).

Densely caespitose or scattered among mosses, pale green or darkening: secondary stems ascending or erect, mostly 1–10 cm.

long, simple, dichotomous or with a few lateral branches, light brown, nearly or quite devoid of root-hairs: leaves alternate, subimbricate, patent-horizontal to erecto-patent, deflexed, orbicular-obovate to obovate-oblong, 1.5–4 mm. long, 1.2–3 mm. in greatest width, the dorsal margin strongly reflexed, the ventral margin decurved and, like the rounded or broadly obtuse apex, dentate or subciliate, or sometimes entire; superior and median leaf-cells 24–48 μ, all with rather small, though distinct, trigones: underleaves usually present, minute, .15–.3 mm. long, lanceolate-subulate and entire or often reduced to a small cluster of capillary filaments: dioicous: androecium terminal or median; ♂ bracts 4–8 pairs, their apices spreading or squarrose; antheridia 1–3, on stalks about equaling their long diameter: ♀ bracts scarcely different from the leaves: perianth obconic-oblong, mostly 4–6 mm. long, 1.6–2.2 in greatest width, sometimes falsely lateral through the development of an innovation, compressed and somewhat twisted toward the bilabiate, ciliate-dentate or denticulate mouth: seta 15–30 mm. long; elaters 140–200 μ long, somewhat tapering at the ends, 9–14 μ in maximum width; spores 16–20 μ, minutely punctulate.

On rocks, soil, and logs, in moist woods. Blue Lake (1005, ♂) and Deer Creek Cañon, Russ & Graham's Ranch (1064, *c. per.*), Humboldt Co. Measurements of spores and elaters are drawn from G. & R. Hep. Eur. 620.

23. LOPHOCOLEA Dumort. Rec. d'Obs. Jung. 17. 1835.

Jungermannia § *Lophocolea* Dumort. Syll. Jung. 59. 1831.

Plants usually moderately large, rarely small, soft and flaccid, mostly yellowish-green or pallescent, forming rather thin effuse mats or repent-spreading. Stems creeping, subsimple or irregularly ramose, the branches lateral or latero-ventral, those bearing the sexual organs sometimes ventral; root-hairs in tufts at the base of the underleaves, colorless, commonly long. Leaves alternate or (in exotic species) often opposite, succubous, decurrent dorsally, for the most part obliquely oblong-ovate, often somewhat triangular, occasionally subquadrate, truncate or more commonly bidentate or bifid at apex, with broad or narrow sinus, the margins otherwise very entire or (in extra-limital species) now and then serrulate, spinose, or ciliate-fringed; leaf-cells usually rather large or medium-sized, thin-walled, occasionally with small trigones at the angles. Underleaves present throughout, cuneiform, ovate, or subquadrate in general outline, in our species deeply bi- or quadrifid with subulate, mostly diverging segments. Dioicous, autoicous, or paroicous. Androecium occupying the end or middle of a

branch; ♂ bracts several pairs, commonly smaller than the leaves, more erect and imbricate, with an incurved lobule at the saccate base, antheridia large, usually solitary. Archegonia numerous, terminal on the main stem or on somewhat elongated branches. ♀ bracts usually somewhat larger than the leaves, often more deeply bifid or more dentate. Perianth exserted, triangular-prismatic, at least when young, with the third angle always dorsal, mostly 2–4 times longer than broad, 3-lobed at the wide mouth, the lobes rarely somewhat truncate and entire, usually bifid and more or less ciliate-dentate or spinose. Calyptra free, thin, shorter than the perianth. Capsule ellipsoid-oval, dehiscing to the base by straight rigid valves; capsule wall of several layers of cells, those of the external layer thick, with columnar or imperfectly semiannular thickenings, those of the inner layers thin, the inmost with numerous semiannular bands; seta long. Elaters bispiral.

Key to the Species.

Leaves all bidentate or bifid, with long subulate-acuminate teeth or segments; autoicous. 1. *L. cuspidata.*

Upper leaves merely retuse, or entire and truncate; paroicous. 2. *L. heterophylla.*

1. LOPHOCOLEA CUSPIDATA (Nees) Limpr.; Cohn, Krypt.-Fl. Schles. 1: 303. 1877.

Lophocolea bidentata cuspidata Nees, Naturgesch. Eur. Leberm. 2: 327. 1836.

Pallid-green, closely caespitose or repent-spreading: stems 6–20 mm. long, .15–.27 mm. in diameter, bearing (especially the fertile) frequent diverging lateral branches, occasionally dichotomous; root-hairs few or moderately abundant: leaves ovate to oblong-ovate, .63–1.6 mm. × .45–1.3 mm., almost equally narrowed to the apex on both sides, bidentate with a broad crescentic sinus or on the more slender branches sometimes bifid ⅓ their length with a rather narrow subobtuse sinus, segments (or teeth) long, subulate-acuminate, subequal and mostly parallel; leaf-cells usually pellucid, somewhat incrassate, the superior and median 24–48 μ, thin-walled, trigones minute or wanting, cuticle smooth: underleaves patent, often only bifid and extrorsely unidentate on either side, or the subulate, commonly divergent, principal segments again bifid: autoicous; antheridia and archegonia borne in most cases on more or less elongated ventral or latero-ventral branches: androecium terminal, rarely median; ♂ bracts somewhat similar to the leaves or smaller, less acutely lobed, and more imbricate, saccate dorsally at the base, the inflexed margin commonly provided with one or two teeth or lobes; antheridia mostly

single, subglobose, .25–.3 mm. in diameter, the very short stalk of a single row of cells: ♀ branches 2–10 mm. long (archegonia sometimes apparently terminal on the main stem), leaves increasing in size upward, becoming more erect and crowded and, like the ♀ bracts, externally canaliculate-concave; ♀ bracts bifid ⅓–½ their length, otherwise usually entire, bracteole similar, almost equally large: perianth longer than the bracts, triangular-prismatic, 2–3.5 mm. × .8–1.3 mm., 3-lobed ¼–½ its length, the lobes usually bifid and often sparingly dentate: capsule dark-brown, 1–1.2 mm. × .65–.72 mm.; spores 16–24 μ, minutely punctulate; elaters contorted, somewhat attenuate at the extremities, 160–220 μ long, 9–12 μ in maximum width.

On decaying sticks, logs, and stumps, in moist woods, rarely on moss-covered trunks of living trees. Not uncommon in the Coast Range Mountains from Marin County northward. Often with perianths, yet rarely with capsules. Olema (27), Marin Co.; North Fork of the Little River (631, 635, 653) and Mendocino (697), Mendocino Co.; Eureka (901) and Blue Lake (988), Humboldt Co.

Lophocolea Leibergii Underwood and Cook, Hep. Am. no. 70 (without diagnosis) cannot, we think, be safely distinguished from the above species.

2. LOPHOCOLEA HETEROPHYLLA (Schrad.) Dumort. Rec. d' Obs. Jung. 17. 1835.

Jungermannia heterophylla Schrad.; Schrad. Jour. Bot. 1801: 66. 1803. Hook. Brit. Jung. *pl. 31.* 1816.

Yellowish-green, caespitose or repent-spreading: stems 5–20 mm. long, .15–.27 mm. in diameter, closely creeping, usually with frequent lateral branches, root-hairs numerous: leaves ovate to subquadrate-oblong, .54–1.3 mm. ×.4–1 mm., very obliquely or almost longitudinally inserted, semivertical, dimorphous, the lower obtusely, or sometimes acutely, bidentate or bilobed, with a rounded-obtuse sinus, the upper retuse, or entire and truncate; superior and median leaf-cells 24–48 μ, the thin walls with distinct trigones at the angles, cuticle nearly smooth: underleaves usually appressed, bifid to below the middle, the subulate-acuminate segments each commonly furnished externally with a single tooth or short cilium: paroicous, rarely heteroicous: ♂ bracts 3–5 pairs immediately below the archegonia or perianth, the uppermost functioning also as ♀ bracts, almost transversely inserted, close, erect-appressed with commonly squarrose apices, truncate or retuse, dorsally ventricose at base with one or two inflexed lobules

or teeth, androecia rarely occurring also at a distance from the archegonia either on the same axis or on special branches; antheridia globose, about .27 mm. in diameter, the short stalk of a single series of cells: ♀ bracts a little larger than the subjacent perigonial leaves, otherwise similar; bracteole deeply bifid with lanceolate-subulate segments: perianth terminal on a more or less elongated latero-ventral branch, longer than the bracts, cylindrical or somewhat goblet-shaped, 1.3–3.2 mm. × .63–1.3 mm., 3-angled toward the mouth and 3-lobed $\frac{1}{6}$–$\frac{1}{3}$ its length, the lobes subtruncate, rarely acute, repand-dentate: capsule brown, 1–1.2 mm. × .75–1 mm.; spores 12–16 μ, minutely punctulate; elaters contorted, slightly attenuate at the extremities, 110–210 μ long, 8–11 μ in greatest width.

On moldering wood (logs, stumps, etc.) in moist cañons, occuring rarely on moist soil in which there is considerable vegetable matter. "Redwood Cañon" (near Mill Valley) and Olema, Marin Co.; Turner's Cañon (between Cazadero and Fort Ross), Sonoma Co.; Big River Boom (near Mendocino, 684), North Fork of the Little River (695), and near "Half-Way House" (726), Mendocino Co.; Eureka (919, 950, 952, 1220), Humboldt Co.

No. 695 was found in a rivulet, apparently of only periodic duration, in "The Plains," North Fork of the Little River, the substratum being sand mixed with vegetable remains. The plants, in this case, are wholly sterile, yet they seem to belong with *Lophocolea heterophylla*, though their habit of growth is more densely caespitose and the leaves are often more acutely bidentate than is usual. All our other Californian specimens occur upon dead wood.

24. CHILOSCYPHUS Corda [as *Cheilocyphos*]; Opiz, Beitr. 651. 1829.*

Vegetative characters of the genus as a whole agreeing very closely with those of *Lophocolea*. Leaves more often entire. Archegonia terminal on a very short ventral or latero-ventral branch. ♀ bracts 1 or 2 pairs, the outer pair (if present) minute, the inner always considerably smaller than the leaves. Perianth usually campanulate or obconical, 3-angled only toward the 3-lobed mouth. Calyptra carnose, especially in the lower part, shorter than the perianth or often much exserted. Sporogonium essentially as in *Lophocolea*.

* See footnote, p. 33.

1. CHILOSCYPHUS POLYANTHOS (L.) Corda; Opiz, Beitr. 651. 1829.*

Jungermannia polyanthos L. Sp. Pl. 1131. 1753. Hook. Brit. Jung. *pl. 62.* 1816.

Jungermannia pallescens Schrad. Syst. Samml. Krypt. Gew. 2: 7. 1797.

Chiloscyphus pallescens Dumort. Syll. Jung. 67. 1831.

Chiloscyphus lophocoleoides Nees, Naturgesch. Eur. Leberm. 2: 365. 1836.

Green or pallescent, closely or laxly caespitose: stems 1–3 cm. long, .18–.45 mm. in diameter, prostrate or ascending, sparingly branched, root-hairs conspicuous or nearly obsolete: leaves close-imbricate or approximate, patent-horizontal, spreading in the plane of the stem or, toward the stem-apex, ascending or semivertical, quadrate-orbicular to oblong, .7–1.6 mm. × .54–1.2 mm., more or less concave ventrally, the apex rounded, subtruncate, or retuse; leaf-cells translucent, the superior and median 32–65 μ; the walls somewhat thickened, yet exhibiting obscure trigones or none at all, cuticle slightly granulate or nearly smooth: underleaves oblong-ovate, bifid to the middle or below, the segments often linear-subulate, occasionally bearing a single tooth or short cilium externally; autoicous; androecium terminal or median on the main stem, ♂ bracts with small dorsal pouches, otherwise similar to the leaves, the margin of the pouch usually with several short inflexed cilia; antheridia single or less commonly in pairs, subglobose, .14–.2 mm. in diameter, the very short stalk composed of a single row of cells; axis of ♀ branch .3–.6 mm. long; ♀ bracts a single pair, with sometimes rudiments of a second (outer) pair, very much smaller than the leaves, retuse or bifid, bracteole minute, bifid; perianth goblet-shaped or obovoid, 2–2.7 mm. long, .9–1.6 mm. in greatest width, deeply 3-lobed, the lobes subtruncate and nearly entire, rarely spinose-dentate: calyptra exserted or included: capsule brown, globose-oval, 1.2–1.5 mm. × 1.1–1.4 mm., the valves rigid, of 4 or 5 layers of cells, those of the external layer thick, with columnar or imperfectly semiannular thickenings, those of the inmost layer with very numerous semiannular bands; spores 14–20 μ, minutely granulate; elaters 120–200 μ × 8–11 μ.

On old logs and on moist ground among mosses. "Paper Mill Creek" [Marin Co.?] (Dr. H. N. Bolander, Sept. 9, 1863); Sisson, Siskiyou Co. (Howe, 37); near Hay Fork, Trinity Co. (1125); North Fork of the Little River (636) and near Mendocino

* See footnote under *Ricciocarpus*, page 33.

(683), Mendocino Co.; Big Valley Mts. and White Horse Lake, Modoc Co. (M. S. Baker and F. P. Nutting).

In our only specimens with sporogonia (Big Valley Mts., Baker and Nutting), the calyptra is included within the perianth or but slightly exserted. The ♀ branches in this originate a little to one side of the middle line of the ventral surface of the stem and are no more strictly ventral than in *Lophocolea cuspidata.* When sterile, there is a possibility of confusing the species with *Lophocolea heterophylla,* but the more entire leaves with larger leaf-cells and usual absence of trigones and the simpler underleaves are commonly distinctive. Antheridia can be found in most specimens and their distribution along the back of the main stem in smaller, more dorsal pouches of otherwise scarcely modified leaves is also characteristic.

1*b*. CHILOSCYPHUS POLYANTHOS RIVULARIS (Schrad.) Nees, Naturgesch. Eur. Leberm. **2**: 374. 1836.

Jungermannia pallescens rivularis Schrad. Syst. Samml. Krypt. Gew. **2**: 7. 1797.

Jungermannia aquatica Schrank (?), Bai. Fl. **2**: 496. 1789.

Aquatic, usually larger in all parts, dark green, with a somewhat fatty lustre: stems 1.5–10 cm. long, more ramose: leaves sometimes broader than long (now and then 2–2.5 mm. broad), mostly rounded at apex; leaf-cells opaque, the superior and median 24–50 μ: underleaves destroyed or wanting except in the youngest parts: always (?) sterile.

EXSICC. Hep. Am. 92.

In running water or on the banks of streams. "California" (Bolander); Cazadero, Sonoma Co.; Navarro (Miss Byxbee), North Fork of the Little River (613), Mendocino Co.; Eureka (956) and Russ & Graham's Ranch (1085), Humboldt Co.; near Douglas City (1143), Trinity Co.; Sisson (35), Siskiyou Co.; Dixey Valley and Bridge Creek, Lassen Co. (Baker & Nutting); Lake Tahoe (W. C. Blasdale, 1897); region of the Yosemite (C. M. Cooke, Jr., 1896).

The variety *rivularis* is often very different from the pale, large- and translucent-celled, wood-inhabiting condition of the species, yet the two appear to be connected by riparian forms. Our Sisson specimen, distributed in Hep. Am. as no. 92, differs considerably

in general aspect from the usual form of the var. *rivularis* owing to the proportionally broader leaves which, in drying, are commonly semivertical or somewhat wrapped around the stem. This grew in very cold swiftly running water.

Jungermannia aquatica Schrank is sometimes quoted as a synonym of *Chiloscyphus polyanthos rivularis*. If a true synonym, the name *aquatica* would replace *rivularis*, according to the provisions of the Rochester Code. But, personally, we are not fully convinced that *Jungermannia aquatica* Schrank is really such a synonym. Schrank's description would, perhaps, on the whole, apply equally well to *Jungermannia cordifolia* Hook.

25. GEOCALYX * Nees, Naturgesch. Eur. Leberm. **1**: 97, 102. 1833. *Et op. cit.* **2**: 395. 1836.

Calypogia Dumort. Syll. Jung. 73. 1831. Not *Calypogeja* Raddi, Atti Soc. Ital. Sci. Mod. **18**:—(33). 1818.

Saccogyna Lindb. *p. p.* Not. Sällsk. Fauna et Flora Fenn. Förhandl. **13**: 377. 1874. Act. Soc. Sci. Fenn. **10**: 509. 1875. Schiffn. *p. p.* Eng. & Prantl, Nat. Pflanzenfam. 1^3: 93. 1893.

Plants resembling in habit *Lophocolea* and *Chiloscyphus*. Stems creeping, simple, or with a few branches, these springing from the axils of the underleaves or latero-ventral; root-hairs usually few, mostly from near the bases of the underleaves. Leaves alternate, succubous, bidentate or bilobed, slightly decurrent dorsally. Underleaves present throughout, much smaller than the leaves, bifid to the middle or below, free or connate with the leaf-base on one side by a very narrow isthmus. Androecium on a short branch from the axil of an underleaf, ♂ bracts considerably smaller than the leaves, unequally and for the most part acuminately bilobed, with an additional tooth or lobule on the dorsal margin; antheridia single or less commonly in pairs, short-stalked, without paraphyses. Archegonia few, terminal on a very short branch springing from the axil of an underleaf, the branch in its further development becoming a fleshy pendulous subterranean sac (perigynium) enclosing the young sporogonium and bearing about its mouth a few inconspicuous scale-like ♀ bracts, these often destroyed on the exsertion of the capsule. Perianth wanting. Calyptra shorter

* The differences in vegetative characters between *Geocalyx graveolens* and *Saccogyna viticulosa* are so striking that we feel unwilling to follow Lindberg, Carrington, Schiffner, Bescherelle, and Kaalaas in reducing *Geocalyx* to *Saccogyna*—at least until we have had an opportunity of examining the exotic species which are said to hold an intermediate position.

than the perigynial tube, with which it is coalesced for two thirds its length, the unfertilized archegonia (1, 2, or 0) situated near the base of the free portion. Capsule nearly cylindrical, dehiscing to the base by straight valves, these composed of two layers of cells, the cells of the outer layer with inconspicuous columnar or nodular thickenings, those of the inner layer with semiannular bands; seta moderately long; involucellum short, goblet-shaped, finally surrounding the base of the seta. Elaters bispiral.

1. GEOCALYX GRAVEOLENS (Schrad.) Nees, Naturgesch. Eur. Leberm. **1**: 98. 1833. *Et op. cit.* **2**: 397. 1836.

Jungermannia graveolens Schrad. Syst. Samml. Krypt. Gew. **2**: 6. 1797.

Saccogyna graveolens Lindb. Act. Soc. Sci. Fenn. **10**: 509. 1875.

Bright or olive-green, caespitose: stems 6–20 mm. long, .22–.3 mm. in diameter: leaves plano-distichous, less commonly semivertical, imbricate or approximate, rather rigid, subquadrate-ovate, .8–1.4 mm. × .55–1 mm., bidentate or bilobed $\frac{1}{6}$–$\frac{1}{4}$ (rarely $\frac{1}{3}$) their length, the lobes acute or now and then somewhat obtuse, parallel or sometimes slightly connivent, the sinuses rounded or subacute; leaf-cells 24–48 μ, scarcely enlarged toward the base, thin-walled with small trigones, the numerous chloroplasts commonly arranged in a ring leaving a clear area in the middle and often a hyaline peripheral border; cuticle finely granulate-papillate: underleaves appressed, bifid to below the middle, the lobes lanceolate, entire, nearly parallel: autoicous: ♂ branch .3–1.2 mm. long: ♀ bracts 4 or 5: perigynium cylindrical, about 2.5–3 mm. × 1 mm., its entire outer surface sparingly radiculose: capsule 1–1.6 mm. × .5–.63 mm.; seta 8–20 mm. long; spores 11–16 μ, slightly granulate-papillate; elaters 110–200 μ × 9–14 μ, somewhat obtuse.

On a charred stump of *Sequoia sempervirens*, Eureka, May 31, 1896 (no. 938). The species occurs also on moist soil and rocks. Our single Californian specimen bears a few perigynia and dehisced capsules, but we have not observed ♂ branches upon it with any certainty.

26. CEPHALOZIA Dumort. *p. p. max.* Rec. d'Obs. Jung. 18. 1835.

Jungermannia § *Cephalozia* Dumort. *p. p. max.* Syll. Jung. 60. 1831.

Nowellia Mitt.; Godman, Nat. Hist. Açores, 321. 1870. Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. 1^3: 97. 1895.

Eucephalozia Schiffn. *l. c.*

Prinolobus Schiffn. *p. p.*; Eng. & Prantl, Nat. Pflanzenfam. 1^3: 98. 1895.

Cephaloziella Schiffn. *l. c.*

Green, whitish, brown, olivaceous, or sometimes tinged with rose-color, small, medium-sized, or minute, depressed-caespitose or creeping among mosses. Stems leafy throughout or rhizomatous at base, or, in some species, flagelliferous, subramose, the branches, with rare exceptions, arising ventrally, root-hairs numerous or scanty. Gemmae occurring in a few species, borne on stem-apex or leaf-margins. Leaves alternate, succubous and sometimes almost horizontal, more rarely nearly transverse, rather broad, more or less concave, bifid from one third to more than one half their length, often subcomplicate, the lobes triangular-ovate, lanceolate, or subulate, sometimes connivent, the margins plane or slightly incurved, never recurved, entire in most, in a very few denticulate or sharply serrate-dentate; leaf-cells from rather large and pellucid to minute and subopaque, the walls thin in most of the species, thickened in a few, especially toward the angles, cuticle smooth or somewhat roughened. Underleaves much smaller than the lateral and often entire, wholly wanting in most species except in the ♀ involucre where they are always represented and often nearly or quite equal the bracts in size. Dioicous, autoicous, or polyoicous, very rarely paroicous. Androecium subamentiform, median or more rarely terminal, sometimes occupying an entire branch; perigonial leaves often a little larger or smaller than the ordinary, more concave and more crowded, sometimes with a small accessory incurved lobule on the dorsal margin; antheridia solitary. Archegonia several or numerous, terminal on a much shortened or sometimes elongated branch or less commonly on the main stem. Bracts free from the perianth, crowded, considerably larger than the leaves, 3-ranked (including bracteoles), usually in three sets, 2–4-lobed, often dentate or incised; inmost bracteole always present, similar to the corresponding bracts and often more or less highly connate with them on one or both sides, the outer bracteoles commonly somewhat smaller, rarely wanting. Perianth more or less highly emersed, 2–7 times longer than broad, distinctly trigonous, at least when young, with one angle always ventral, or sometimes 4–6-angled, its wall of one layer of cells or, in some species, 2- or 3- stratose toward the base, commonly constricted at the denticulate, ciliate, laciniate, or subentire mouth. Calyptra small, thin, or rarely

fleshy, surrounded at the base by the sterile archegonia. Capsule long-exserted on a very delicate pellucid seta, cylindrical-oblong, or oblong-globose, quadrivalvular to the base, the walls bistratose, cells of the inner layer with semiannular thickenings. Elaters bispiral, deciduous, subobtuse, mostly 150–200 μ long and 8–10 μ wide. Spores smooth or minutely roughened, about 8–10 μ.

Key to the Species.

Leaf-cells 30–60 μ.

Leaves bifid to the middle or a little below, longer than broad; perianth-wall unistratose unless at extreme base. 1. *C. bicuspidata.*

Leaves bifid about $\frac{1}{3}$ their length, commonly as broad as long or broader; perianth-wall of 2 or 3 layers of cells for $\frac{1}{6}$–$\frac{2}{3}$ its length.

Dioicous; leaves .18–4 mm. in diameter, decurrent, nearly horizontal or subassurgent. 3. *C. media.*

Monoicous (polyoicous?); leaves .3–.55 mm. in diameter, scarcely or not at all decurrent, assurgent or vertical-connivent. 2. *C. pleniceps.*

Leaf-cells 10–20 μ.

Ramification ventral; leaves distant or subimbricate, their lobes usually very entire and often divergent. 4. *C. divaricata.*

Ramification commonly lateral; leaves mostly approximate, often crowded and equitant, complicate-bilobed, the margins sharply and unequally serrate-dentate. 5. *C. Turneri.*

1. CEPHALOZIA BICUSPIDATA (L.) Dumort. Rec. d'Obs. Jung. 18. 1835.

Jungermannia bicuspidata L. Sp. Pl. 1132. 1753. Hook. Brit. Jung. *pl. 11.* 1816.

Jungermannia Lammersiana Hüben. Flora, **15**: 306. 1832.

Jungermannia extensa Tayl. Lond. Jour. Bot. **5**: 279. 1846.

Cephalozia extensa Spruce, On Cephalozia, 44. 1882.

Eucephalozia bicuspidata Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. I^3: 97. 1895.

Greenish or pallid, more rarely rufescent or tinged with rose-color, prostrate or assurgent-caespitose, often flagelliferous: stems rather sparingly branched, 4–20 mm. long, nearly terete, 6 or 7 cells in diameter, the cortical cells large and pellucid, the interior much narrower: leaves orbicular-ovate, sometimes oblong-ovate, mostly .3–.65 mm. long, obliquely attached or subtransverse, the inferior distant or approximate, the superior commonly large and subimbricate or crowded, all bifid $\frac{1}{2}$–$\frac{3}{5}$ their length, concave, often subcomplicate, the sinus obtuse, lobes ovate-lanceolate, triangular-lanceolate, or subtriangular, connivent or patent, subacuminate or the ventral merely acute, sometimes—especially the dorsal—attenuate to an apiculus 2–4 cells in length; leaf-cells rather large,

thin-walled, pellucid, somewhat thick, quadrate-hexagonal, becoming elongated toward base, 30–60 μ; underleaves usually wanting except in association with the ♀ bracts: polyoicous: androecium median, terminal, or occupying an entire branch, the perigonial leaves much like the others but more concave, usually closer, and sometimes with a small accessory tooth on the dorsal margin near the base: archegonia terminal on a very short or much elongated branch: bracts about three pairs; the inmost 2–3 times longer than the leaves, sometimes slightly connate at the base, bifid to the middle, the lobes mostly lanceolate-acuminate, entire, repand, or with one or two teeth near the base; bracteole similar: perianth linear-subfusiform, thrice longer than the bracts, 1.8–2.5 mm. × .5 mm., at first tricarinate-prismatic, later often becoming nearly terete below, remaining trigonous toward the constricted denticulate or setulose mouth, its wall unistratose throughout unless at the extreme base: calyptra thin: capsule cylindrical-oblong, .6–.75 mm. × .3–.4 mm.; spores purple.

On decaying wood, moist soil, and in swamps among mosses.

Mendocino (Dr. Bolander; Howe, 719) and North Fork of the Little River (610, 615, 652, 659, 661, 689), Mendocino Co.; near Eureka (916, 963, 1031).

An examination of *Jungermannia extensa* Tayl. from "Observatory Inlet, N. America, Dr. Scouler, 1834" in the Taylor collection, now incorporated in the Gray Herbarium, Cambridge, Mass., shows, we think, no satisfactory and reliable grounds for its separation from *C. bicuspidata*. Spruce (On Cephalozia, 45) emphasizes only the "cladogenous perichaetia" as distinguishing it from *C. Lammersiana*, but we find the ♀ branches in the original material often much elongated as in *C. Lammersiana;* flagella are not wholly wanting; the leaves are commonly bifid to below the middle, but they can be matched in this respect by European specimens as also in respect to the apiculus of the leaf-lobes. Most of the Californian specimens are dioicous and agree closely with the original of Taylor's *Jungermannia extensa.*

The specimens which we once reported (Erythea, **4**: 50. 1896) from California under the name *Cephalozia bicuspidata* belong with *C. media* but have somewhat thinner perianths than is normal with that species.

2. CEPHALOZIA PLENICEPS (Aust.) Lindb. Medd. Soc. Faun. et Fl. Fenn. **9**: 158. 1883.

Jungermannia pleniceps Aust. Proc. Acad. Nat. Sci. Philad. 1869: 222. 1869.

Cephalozia crassiflora Spruce, On Cephalozia, 40. 1882.

Pale green, sometimes lightly tinged with brown, densely caespitose, now and then suberect and forming compact cushions: stem subramose, rather stout, about 8 cells in diameter, flattened dorsally, the cortical cells large and pellucid, branches occasionally stoloniform: leaves obliquely orbicular, mostly .3–.55 mm. in diameter, strongly concave, assurgent, often vertical-connivent, subimbricate, more rarely distant, scarcely or not at all decurrent, bifid about one third their length, the sinus obtuse, less commonly acute, the lobes acute or the ventral occasionally subobtuse, often more or less connivent; leaf-cells quadrate-hexagonal, becoming oblong-hexagonal toward the base, rather large and thick, pellucid, thin-walled, 30–60 μ: rudimentary underleaves rarely present toward the apex of the younger branches: monoicous (polyoicous?): androecium median or terminal, dorsal lobe of perigonial leaves commonly with an incurved tooth or lobule near its base: ♀ branch very short or somewhat elongated; the inmost bracts bi- to quadri-fid, distinct or slightly connate with each other and with the bracteole, often bistratose at the base, the segments acute; bracteole usually bi–tri-fid; perianth cylindrical-oblong, 2.3–2.8 mm. × .6–.9 mm., contracted at the plicate, denticulate mouth, carnose, of three layers of cells at the base and bistratose to the middle or even for two thirds its length; calyptra mostly unistratose.

On the ground beside a stream, near Sisson, Siskiyou Co., growing among Musci (*Aulacomnium*, etc.) and forming a compact turf.

The type specimen, from the White Mountains of New Hampshire (legit Oakes) is in the possession of Mr. W. H. Pearson.

The Californian plant has a rather narrower and more fleshy perianth than the original, the wall of this organ being in the former bistratose for two thirds its length, in the latter only about to the middle. *Cephalozia crassiflora* Spruce—from the Pyrenees—an authentic specimen of which, also, we have seen in herb. Pearson, seems to differ from the original *C. pleniceps* in scarcely anything but in having the perianth widest above the middle, while in both the New Hampshire and California plants the perianth is com-

monly widest at the middle or a little below. We are of the opinion, first ventured as a suspicion by Dr. Spruce (On Cephalozia, 41) and afterwards confirmed by Mr. Pearson (List of Canadian Hepaticae, 9) that *Cephalozia crassiflora* is a synonym of *C. pleniceps*.

We have here some grounds for believing that our Californian specimen is dioicous as well as monoicous but the branches of a *Cephalozia* can be so easily disarticulated in manipulation that we dare not assert this with positiveness.

Cephalozia pleniceps can be distinguished from its near ally *C. media* by the twice larger, scarcely or not at all decurrent, more nearly orbicular and less rhomboidal leaves, which incline to be vertical-connivent instead of horizontal or subassurgent, by the broader, merely acute lobes, the thinner calyptra, the rather more fleshy perianth, etc. This species seems always to be found in company with mosses in swamps, beside streams, and on moist rocks, while *C. media*, in California at least, affects logs and decaying wood almost exclusively.

PLATE 104. CEPHALOZIA PLENICEPS.

1. Portion of plant showing perianth and androecium, × 12.
2. Portion of a sterile stem, with leaves, × 23.
3. ♀ branch showing perianth and bracts, dorsal view, × 12.
4. The same, ventral view, × 12.
5. Another ♀ branch, with perianth and bracts, dorsal view, × 12.
6. ♀ branch, lateral view, the perianth undeveloped, × 23.
7. A thin longitudinal microtome section of perianth, × 23.
8–11. Cauline leaves, showing the outer (convex) face, × 23.
12–14. Bracts, × 23.
15. Bracteole, × 23.
16. Second (next to the inmost) bracteole, × 23.
17. Portion of perianth mouth, × 41.
18. Cross-section of stem, × 53.
19–21. Bases of bracts with adjacent parts of stem, in sectional view, × 41.
22. A cauline leaf, × 41.

Figs. 2–4 and 12–17 from the original specimen collected in the White Mts. of New Hampshire by Mr. Oakes, ex herb. Pearson; the remaining figures from our specimen collected at Sisson.

3. CEPHALOZIA MEDIA Lindb. Medd. Soc. Faun. et Fl. Fenn. 6: 242. 1881.

C. multiflora Spruce, On Cephalozia, 37. 1882.

Eucephalozia media Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. I^3: 97. 1895.

Slender, bright- or pallid-green, prostrate, forming close depressed mats or rarely laxly creeping, rather sparingly and irregularly ramose, the apices often ascending: stem somewhat flattened dorsally, the cortical cells large and pellucid: leaves small, orbicular-rhomboidal, .18–.4 mm. in diameter, subimbricate and somewhat assurgent or often distant and nearly horizontal, decurrent dorsally, bifid about one third their length with an obtuse or rarely lunate sinus and connivent, acute or subacuminate lobes; leaf-cells pellucid, 30–45 μ: dioicous: androecia occupying the end, rarely the middle of mostly rather short branches: inmost bracts of the very short ♀ branch about three times larger than the outer, orbicular-oblong, bi–quadri-fid, the segments acute or acuminate, entire; bracteole nearly similar, sometimes connate with the bracts: perianth oblong- to linear-fusiform, 1.5–2.4 mm. × .4–.8 mm., constricted and denticulate at the mouth, of 2 or 3 layers of cells toward the base, sometimes 2-stratose as high as the middle, the remainder unistratose; calyptra 2- or 3-stratose throughout: capsule cylindrical-oblong, .6–.8 mm. × .28–.5 mm.; spores cinnamon colored.

On decaying logs in moist shaded places, rarely on the ground. Common in the Coast Range Mountains, north of San Francisco.

Redwood Cañon near Mill Valley, and near Olema (28), Marin Co.; Duncan's Mills and Turner's Cañon, Sonoma Co.; Navarro (Miss Byxbee), North Fork of the Little River (656), Mendocino (572, 573, 598, 665, 674), Half-Way House (725), Mendocino Co.; Eureka (904, 949), Humboldt Co.; near Hay Fork, Trinity Co. (1124); Sisson, Siskiyou Co. Collected in Marin Co. also by Professor Underwood and said to have been found in California also by Dr. Bolander.

The perianth in our specimens is usually of a thinner texture than is ascribed to *Cephalozia multiflora* by Dr. Spruce. It is rarely that the perianth-wall is 2-stratose so far as the middle. In most cases the perianth-wall is of more than one layer of cells only in the lower third or fourth, sometimes even only in the basal sixth, yet we have been able to discover no other character to distinguish the Californian plant from the European and an examination of European specimens seems to indicate that this character is susceptible to some variation even there.

4. CEPHALOZIA DIVARICATA (Sm.) Dumort. Hep. Europ. 89. 1874.

Jungermannia divaricata Sm. Eng. Bot. *pl. 719.* 1800.

Jungermannia Starkii Funck ; Nees, Naturgesch. Eur. Leberm. **2**: 215, 225. 1836.

Cephaloziella divaricata Schiffn. ; Eng. & Prantl, Nat. Pflanzenfam. 1^3: 99. 1895.

Very small, green, olivaceous, or nearly black, sometimes tinged with rose-color, closely caespitose or laxly creeping among mosses, prostrate or ascending, eflagelliferous ; stem stout for the size of the plant, 2–10 mm. long, sparingly branched, about 7 or 8 cells in thickness, the cortical in 14–22 series, not different from the interior or a little smaller, root-hairs often rather abundant: leaves small, scarcely longer than the diameter of the stem or twice as long, subquadrate or rotund-quadrate, .08–.18 mm. in length, .08–.2 mm. in width, distant or subimbricate, nearly transverse, bifid to the middle or a little below, the lobes triangular-ovate, acute, subacuminate, or nearly obtuse, divergent or subcomplicate, entire, slightly repand, or now and then with a single small tooth on one side or the other; leaf-cells subquadrate, minute, 10–16 μ, subopaque or pellucid, the walls thin or somewhat thickened especially at the angles, cuticle smooth or minutely granulate ; stem-apex and margins of the apical leaves sometimes gemmiferous : underleaves wanting, or present in the younger parts, entire and subulate or lanceolate, or sometimes broader and emarginate or bifid : dioicous : androecium terminal or median, cauline or rameal, the perigonial leaves in several pairs, concave, appressed-imbricate, commonly a little larger than the ordinary leaves, less deeply and more acutely lobed : archegonia terminal on the main stem or on an elongated branch : bracts in three pairs, 2 or 3 times larger than the leaves, bilobed or rarely trilobed, usually distinct dorsally but commonly highly connate with the bracteole, the lobes acute or acuminate, denticulate, subspinulose, or nearly entire, often hyaline at the apex ; bracteole similar, outer bracteoles two, somewhat smaller than the corresponding bracts and less deeply cleft ; perianth fusiform-ovoid to linear, .8–1.4 mm. × .2–.4 mm., prismatic, 3–6-angled, mostly hyaline toward the apex and sometimes purplish below, somewhat contracted at the denticulate or subentire mouth, the wall unistratose.

On logs, charred stumps, rocks, and moist soil, commonly associated with mosses and other hepatics.

Frequent in the Coast Range region. Clarendon Heights, San Francisco ; Mill Valley, Mt. Tamalpais, and Lake Lagunitas, Marin Co.; Cazadero, Sonoma Co.; Mendocino (544, 619, 669), North Fork of the Little River, and Ukiah (741), Mendocino Co.; Eureka (956) and Blue Lake (995), Humboldt Co.; Mt. Diablo,

Contra Costa Co.; Fruit Vale, Alameda Co. (Miss Edith S. Byxbee). Also gathered by Dr. Bolander.

In the Californian specimens, underleaves can nearly always be detected toward the apex of the younger stems or branches.

4*b*. **Cephalozia divaricata scabra** var. nov.

Leaves mostly opaque, often of two or three layers of cells at base, especially near the median line, the back near the fold usually papillate, verrucose, spinulose-dentate, subciliate, almost lamelligerous, or subradicelliferous, the margins now and then subdenticulate or at the base even spinulose-dentate, the lobes sometimes apiculate, cuticle of the leaf-cells distinctly roughened: stems exhibiting rarely here and there minute paraphyllia-like appendages, usually composed of 2 or 3 cells in a lineal series: perianth-wall often bistratose in the basal fourth or fifth.

On rocks. Near Hay Fork (1110), Trinity Co.; Doolan's Cañon (776), near Ukiah, Mendocino Co.; Cazadero, Sonoma Co.,

This variety, especially as represented in the first two specimens cited, is so strikingly different from the normal form that we were at one time on the point of treating it as a species, which we were finally deterred from doing by discovering that two or three of our Californian specimens, *e. g.*, those cited under *C. divaricata* from Mt. Diablo and (in part) from Lake Lagunitas, seem to hold a clearly median ground, the leaf peculiarities of the two forms being in one observed case even exhibited in different parts of a single plant. We have sometimes seen a very distinctly roughened or subpapillate cuticle in European specimens of *C. divaricata*, *e. g.*, Carr. & Pears. Hep. Brit. 261, but spinulose teeth or even short cilia 2 or 3 cells long from the back of the leaf we have been unable to discover elsewhere and we find no record hitherto of any such peculiarity in this species or its allies.

5. CEPHALOZIA TURNERI (Hook.) Lindb. Acta Soc. Sci. Fenn. **10**: 502. 1875.

Jungermannia Turneri Hook. Brit. Jung. *pl. 29*. 1816.

Anthelia Turneri Dumort. Rec. d'Obs. Jung. 18. 1835.

Prionolobus Turneri Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. **I**^{3}: 98. 1895.

Bright green, becoming pallid or rusty-brown, very small, depressed-caespitose or creeping among mosses; stems 2–6 mm. long, terete, 60–100 μ in diameter, usually ascending at the apex, subramose, the branches lateral, very rarely strictly ventral, cortical cells subpellucid, root-hairs rather few: leaves mostly approximate, often crowded and equitant, complicate-bilobed ½–⅔ their length, the margin everywhere sharply and unequally serrate-dentate, the lobes ovate or ovate-lanceolate, acute or apiculate, the dorsal suberect and somewhat parallel to the stem, the slightly broader ventral usually patent; leaf-cells quadrate-hexagonal, 14–20 μ, the walls strongly thickened especially near the angles: underleaves wanting: polyoicous: androecium usually median, the perigonial leaves similar to the others but sometimes a little larger and more closely imbricate: archegonia terminal on a commonly much elongated branch: bracts two or three pairs, increasing in size upward, the inmost twice the size of the leaves, often highly connate with each other and with the bracteole, spinulose-dentate, bifid, the lobes acute or subacuminate; bracteole ovate, subacuminate, spinulose-dentate, otherwise usually entire, sometimes connate with only one of the bracts; outer bracts commonly distinct, outer bracteoles wanting or only one present; perianth linear-oblong, 1 mm. × .25–.35 mm., pentagonal-prismatic with pronounced carinae, of a single layer of cells or sometimes bistratose at the extreme base or at the angles, often decolorate toward the rounded apex, the mouth nearly closed, denticulate or very obscurely ciliolate: capsule oblong-oval, .35–.4 mm. × .22 mm.

On stony, lightly shaded banks and on sandy soil, sometimes associated with *Claopodium leuconeuron* and *Catharinea undulata* or with *Nardia crenulata*, rarely on logs or ascending the bases of stumps of *Sequoia sempervirens*.

Marin Co. (Miss M. E. Parsons, May, 1888, in herb. Underwood), Mill Valley (Howe, May 3, 1894, Dec. 31, 1895, Feb. 22, 1896), "Redwood Cañon" on the slopes of Mt. Tamalpais; Duncan's Mills and near Cazadero, Sonoma Co.; Mendocino (584, 618), North Fork of the Little River (687), and Half-Way House (732), Mendocino Co.; near Eureka (974, 1030), Humboldt Co.; near Lake San Andreas, San Mateo Co.; Twin Oaks, San Diego Co. (F. W. Koch, Dec. 28, 1895).

Exsicc. Hep. Am. 174.

The above species, first described from Bantry, Ireland, and since recorded from a few other localities in Ireland, England, France, the Canary Islands, and northern Morocco, seems to be

more common in the coast counties of California than in the Old World. The only European specimen that we have been able to use for comparison is one collected by G. Davies in Ashdown Forest, Sussex, England, in 1881, which we owe to the generosity of Matthew B. Slater, Esq., of Malton; this unfortunately lacks mature perianths, yet the correspondence of the Californian plants with it, so far as it goes, and with the detailed description of the species given by Dr. Spruce is so close that we have no ground for doubting their specific identity. A slight difference possibly lies in the more frequent occurrence in the Californian specimens of concrescence on both sides between bracteole and bracts, forming a complete cup with an erect acutely lobed limb, yet Spruce says of the specimens collected in Ireland by Lindberg, "*bractae intimae cum bracteola biloba in excipulum alte connatae*";* on the other hand, the bracteole in our plants is sometimes free on one margin and the bracts may even be found, though very rarely, to be quite distinct dorsally.

The collection of this species in San Diego County by Mr. Koch suggests that it probably occurs also in the intervening coast region.

27. KANTIA S. F. Gray (as *Kantius*) Nat. Arr. Brit. Pl. 1: 706. 1821.

Calypogeja Raddi *p. p. min.* Atti Soc. Ital. Sci. Mod. **18**:—(31). 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 42. 1820.

Cincinnulus Dumort. Comm. Bot. 113. 1822.

Calypogeia Corda; Opiz, Beitr. 653. 1829.†

Plants medium-sized, depressed-caespitose, light green, sometimes darkening on drying. Stems prostrate, or ascending at the often gemmiparous apices, subsimple or with irregularly disposed branches, these, with rare exceptions, arising somewhat laterally from the axils of the underleaves; root-hairs very long, usually numerous, springing in clusters from the base of the underleaves. Leaves alternate, incubous, plane or slightly convex, oblong, ovate, or subrhomboidal, rounded or retuse at the apex, less commonly acute, bidentate, or bilobed, the margins entire; leaf-cells rather large, chlorophyllose or pellucid, rarely with trigones. Under-

* Spruce, On Cephalozia, 72. 1882.

† See footnote, page 33.

leaves present throughout, usually $\frac{1}{6}$–$\frac{1}{2}$ the size of the leaves, suborbicular, or sometimes reniform or ovate, the apex bifid, retuse, or entire. Dioicous, autoicous, or paroicous. Sexual branches arising, singly, in pairs, or in groups of three, from the axils of the underleaves, the ♂ branches always originating near the basal margin of the underleaf, the ♀ commonly median. Androecium (in autoicous and dioicous sp.) small, capitate or linear-amentiform, ♂ bracts very small, bifid. ♀ bracts 2 or 3 pairs with similar bracteoles, much smaller than the leaves, suborbicular, ovate, or lanceolate, subentire or 2–4-lobed; archegonia 4–12. Perianth wanting; the ♀ branch developing into a fleshy pendulous subterranean radicelliferous cylindrical or clavate pouch (perigynium), crowned at the mouth with the persistent scale-like bracts and lined internally with clavate-papilliform cells. Calyptra, at maturity, adnate for three fourths or more of its length with the perigynium, and almost equally long, its free portion surrounded by the abortive archegonia. Capsule cylindrical, dehiscing to the base by linear spirally wound valves, these bistratose, the walls of the outer layer of cells nearly or quite destitute of local thickenings, those of the inner layer with numerous semiannular bands; seta long; involucellum highly developed, finally adnate to the calyptra and reaching nearly to the line of departure of calyptra and perigynium-wall, its cells elongated and sinuous. Elaters bispiral.

1. KANTIA TRICHOMANIS (L.) S. F. Gray, *l. c.*

Mnium trichomanis L. Sp. Pl. 1114. 1753.

Jungermannia Trichomanis Dicks. Pl. Crypt. **3**: 10. 1793. Hook. Brit. Jung. *pl. 79.* 1816.

Jungermannia Sprengelii Mart. Fl. Crypt. Erlang. 133. *pl. 3. f. 6.* 1817.

Cincinnulus Trichomanis Dumort. *l. c.*

Calypogeia Trichomanis Corda, *l. c.* Nees, Naturgesch. Eur. Leberm. **3**: 8. 1838.

Densely depressed-caespitose or straggling among mosses: stems 8–25 mm. long, .1–.36 mm. in diameter, simple or sparingly branched, prostrate and terminating obtusely, or often attenuate, ascending, and microphylline at the apex and crowned with a subglobose cluster of gemmae: leaves usually closely imbricate, ovate, .9–.18 mm. × .63–1.4 mm., slightly decurrent ventrally, becoming, in the more slender conditions, smaller, merely approximate or even somewhat distant, subrhombic, dimidiate-ovate, and strongly decurrent, apex in all commonly rounded, occasionally

retuse, sometimes acute, rarely bidentate; superior and median leaf-cells 35–65 μ, the chloroplasts mostly close to the vertical walls, trigones wanting or indistinct; gemmae ovoid, of one or two cells: underleaves orbicular to broadly ovate, 1–3 times as broad as the stem, distant, approximate, or imbricate, bifid to below the middle or merely retuse, the lobes acute or obtuse, entire or rarely with a tooth on the outer margin: autoicous (polyoicous?): androecium short and capitate or becoming linear-amentiform and attaining a length of 1 mm. or more, arising from the same axil with the ♀ branch or at a distance from it; antheridia solitary, ovoid, about .1 mm. in greatest diameter, short-stalked: archegonia 4–7: perigynium cylindrical, 1.5–2.5 mm. × .6–.9 mm.: capsule 1.5–2.5 mm. × .55 mm.; seta 1–2.5 cm. long; spores 12–16 μ, very minutely punctulate; elaters 180–350 μ × 11–15 μ, rather obtuse.

On moist banks and decaying logs. Common in the Coast Range Mountains. Mill Valley, Redwood Cañon, and Olema, Marin Co.; Duncan's Mills (*c. fr.*) and Cazadero (*c. fr.*), Sonoma Co.; North Fork of the Little River (640, 660, 696) and Mendocino (583), Mendocino Co.; Eureka (903, 1221), Humboldt Co. Collected also by Dr. Bolander at Mendocino and in "Devil's Cañon, Forest Hill, Sierra Nevada, no. 4620."

The Californian specimens belong chiefly to what is sometimes treated as a variety or species under the name *Sprengelii*, departing from the form ordinarily considered typical in the smaller more ovate underleaves, which are deeply bifid, with the lobes acute. The underleaves, however, often show such extremes of form and size in a single tuft and such gradual transitions between these extremes that we are convinced that any attempt to divide this group into two species according to the character of the underleaves is both unnatural and inconvenient. While the Californian specimens represent, in our opinion, but a single species, the determination of what name this species shall bear is attended with some little difficulty owing principally to the various ways in which *Kantia trichomanis* has been interpreted and defined by European authors. Lindberg * has made the relation of the antheridia to the archegonia a ground for distinguishing *Kantia calypogeia* (Raddi) Lindb. from *Kantia trichomanis*, describing the former as autoicous and the latter as paroicous, and Kaalaas † has

* Hep. Utveck. 32. 1877. Kongl. Sv. Vet.-Akad. Handl. 23^5: 25. 1889.

† Nyt Mag. for Naturvidensk. 33: 201. 1893.

correlated with these characters others drawn chiefly from the underleaves and leaf-apices. Nees von Esenbeck,* however, gives the impression that his *Calypogeia trichomanis* is dioicous and the species is so described by Limpricht † and by Stephani.‡ Gottsche § on the other hand, twice states that the ♂ and ♀ branches may arise side by side from the axil of a single underleaf. Spruce remarks: ¶ "Our *Kantia Trichomanis* (*Calypogia Tr.*, Syn. Hep.) is also certainly monoicous, and fruits freely in the Castle-Howard woods in the springtime. The flowers stand normally three together, in the axil of a foliole, thus (♂ ♀ ♂); but one or other flower in each triplet is apt to be obsolete, thus obscuring the monoicous character. We have probably a second species, in bogs and wet places, with dioicous inflorescence, and large, very slightly notched (or even quite entire) folioles; but I have seen no fertile specimen." In a reprint of this paper ("On Anomoclada") in possession of Professor Underwood, Dr. Spruce has written "*K. Trichomanis*" on the margin opposite the words "probably a second species" and "*K. Sprengelii*" (Mart.)" opposite the reference to the monoicous species. In none of the Californian specimens (and in none from the eastern United States, so far as investigations have been made) have we been able to demonstrate paroicous inflorescence. By persistent searching we have always been able to find antheridia, when they are to be found at all, occupying purely ♂ branches on plants which bear also ♀ branches There is, however, an apparent tendency to become dioicous, which is especially pronounced in plants with large, merely emarginate underleaves. In European specimens, also, we are satisfied that the correlation, as defined by Kaalaas, between the position of the antheridia and the characters of the underleaves, leaf-apices, etc., does not always exist. For example, an autoicous or perhaps polyoicous specimen collected in Germany by Herr F. Stephani has leaves and underleaves which are very decidedly of the type

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* Naturgesch. Eur. Leberm. 3: 19. 1838.

† Cohn, Krypt.-Fl. Schles. 1: 310. 1877.

‡ Berichte Bot. Ver. Landshut, 7: 143 (51). 1879.

§ Acta Acad. Caes. Leop.-Carol. Nat. Cur. 21^2: 427. 1845. Abhandl. Naturw. Ver. Hamb. 7: 41. 1880.

¶ Jour. Bot. 14: 164. 1876.

conceived by Kaalaas to be peculiar to *Kantia trichomanis*. It should, perhaps, be remarked that in European, as in American, specimens of *Kantia trichomanis*, we have as yet been unable to discover antheridia in the axils of the ♀ bracts—doubtless due to the fact that most of the European specimens of *Kantia trichomanis* accessible to us are in an unfavorable condition for the demonstration of antheridia. To what extent paroicous inflorescence prevails in the European plants and in how far and how constantly it may be associated with other characters are matters which we hope will soon be exhaustively investigated by European hepaticologists. Inasmuch as Linnaeus' specimen of *Mnium trichomanis*, if he ever had one, is not preserved, it would appear that the only way of interpreting the diagnosis, "*Mnium foliis distichis integerrimis*" is by calling to our assistance the only synonym that he quotes, viz.: "*Mnium trichomanis facie, foliolis integris.* Dill. musc. 236. *t. 31. f. 5.*" This Dillenian plant Lindberg has declared * to be "*Kantia calypogea* (Dood.; Radd.) Lindb. saccifera.—Haec species est autoica, *K. trichomanis* (L.) Lindb. tamen paroica." On this showing it seems a little strange that Lindberg should not have pinned the name "*trichomanis* (L.)" down to the autoicous form and given his paroicous species a new name. It is, however, to be noted that this determination is out of harmony in one or two particulars with his earlier determinations of the plants preserved in the Dillenian herbarium, for he once wrote :† "Secundum specimina, in herbario ejus nunc asservata, *Mnium* Dillen. Hist. musc. tab. 31, figg. et 5 et 6 ad *K. trichomanis α 2 fissam* [afterwards *K. calypogeia* (Raddi) Lindb.] pertinent! Sed (fig. 5) caespes componitur et ab hac forma (dioica), ♂ et sacculos juveniles gerente, et ab intermixta *K. arguta*, ster. et gonidiifera!" One will observe that the sacciferous plant is here declared to be dioicous! Whether the determination of three years later was a rectification based upon a reëxamination of the Dillenian specimen we are not informed. But whether autoicous or dioicous, it certainly appears quite unjustifiable to limit the name "*trichomanis*" to an exclusively *paroicous* form.

* Hep. Utveck. 32. 1877.

† Not. Sällsk. pro Fauna et Flora Fenn. Förhandl. 13: 364. 1874.

28. LEPIDOZIA * Dumort. Rec. d'Obs. Jung. 19. 1835. G. L. & N. Syn. Hep. 200. 1845.

Pleuroschisma § *Lepidozia* Dumort. Syll. Jung. 69. 1831.

Mastigophora Nees, Naturgesch. Eur. Leberm. **1**: 95, 101. 1833.

Herpetium § *Lepidozia* Nees, *op. cit.* **3**: 31. 1838.

Plants small or moderately large, pallescent or yellowish-green, in dense, often depressed mats. Stems prostrate or ascending, rarely erect or pendulous, pinnately or bipinnately branched, often beautifully plumose, the vegetative branches lateral in origin, rarely ventral; root-hairs rather scanty, mostly from the ventral surface of the underleaves. Leaves incubous, small, ventrally concave, decurved, unsymmetrical, usually as broad as long, palmately 4- (rarely 2- or 3-, or 5- or 6-) cleft or -parted, the segments lanceolate or subulate and (in our species) entire; leaf-cells rather small or medium-sized. Underleaves present throughout, similar to the leaves but symmetrical and somewhat smaller. Dioicous or autoicous. Androecium occupying a short ventral ramulus or rarely terminal on a lateral branch; ♂ bracts suborbicular, saccate-concave, larger-celled, mostly bilobed, bracteoles much smaller; antheridia single. Archegonia few or numerous, terminal on a short ventral, often strongly radicelliferous, branch. ♀ bracts 3–5 pairs, the inmost mostly three times larger than the cauline leaves, all larger-celled and more translucent, 2–4-lobed or -dentate at apex, the margins entire, denticulate, or spinose: bracteoles similar. Perianth free, cylindrical-ovoid to narrowly fusiform, more or less distinctly trigonous above, with the third angle ventral, gradually contracted at the apex toward the rather small denticulate or ciliate-laciniate mouth. Calyptra ½–¼ as long as the perianth. Capsule cylindrical-ovoid, dehiscing to the base by straight valves, these 2–4-stratose, the walls of the external cells with columnar or nodular thickenings, those of the inmost layer with semiannular bands; seta moderately long. Elaters bispiral.

* In order to retain in use *Lepidozia* as a generic name, we recognize its subgeneric priority. The *Mastigophora* Nees of 1833 was rather briefly defined and no species were cited under it, yet in 1838 Nees mentions *Mastigophora reptans* as a synonym of *Herpetium reptans* and refers to page 101 of the first volume of the Eur. Leberm. as the place of publication, where, however, no specific names are to be found. There can, therefore, be no possible doubt as to what Nees intended to have understood under his *Mastigophora* of 1833. But in 1838 Nees reverted to Dumortier's sectional name *Lepidozia* (using it for a section of *Herpetium*, and without any allusion to Dumortier's work of 1835, in which *Lepidozia* was raised to generic rank) and forthwith transferred the name *Mastigophora*, with full diagnosis, to a very different plant (*Jungermannia Woodsii* Hook.).

1. LEPIDOZIA REPTANS (L.) Dumort. Rec. d'Obs. Jung. 19. 1835.

Jungermannia reptans L. Sp. Pl. 1133. 1753.

Pleuroschisma reptans Dumort. Syll. Jung. 69. 1831.

Herpetium reptans Nees, Naturgesch. Eur. Leberm. **3**: 31. 1838.

In depressed mats or creeping among mosses: stems prostrate, 6–25 mm. long, .18–.36 mm. in diameter, subpinnately to bipinnately ramose, the branches ending obtusely or often becoming flagelliform: leaves obliquely inserted, patent-horizontal to erecto-patent, mostly approximate or subimbricate, rarely distant, subquadrate, inclining occasionally to ovate or obovate, .36–.45 mm. long, .25–.54 mm. broad, decurved, 3- or 4- (rarely 2-) cleft for ⅓–½ their length, the lobes unequal, mostly lanceolate-acute or subulate, incurved, 4–8 cells wide at base; leaf-cells 24–48 μ, their firm walls obscurely or not at all incrassate at the angles, cuticle smooth: underleaves distant or contiguous, subquadrate, broader than long, ⅖–⅔ the size of the leaves, mostly 4-lobed to about the middle, the lobes usually obtuse: autoicous: androecium typically on a short ventral branch, rarely borne on a branch of lateral origin: axis of ♀ branch about .5 mm. long, archegonia 2–6: ♀ bracts 2–3-dentate at apex, margins entire or slightly denticulate: perianth subcylindrical or narrowly ovoid-conical, 2–2.7 mm. long, .63–1 mm. in greatest width (below the middle), rounded-trigonous above, the wall of 2 or 3 layers of cells in the basal half or third, otherwise unistratose, the mouth denticulate: capsule about 1.2 mm. × .7 mm.; seta 1–2 cm. long; spores 14–16 μ, distinctly granulate-papillate; elaters 200–325 μ × 10–16 μ, rather obtuse.

On old logs in moist woods, on banks of streams, among mosses, etc. Not especially common in California. "Redwood Cañon," near Mill Valley, Marin Co.; near Mendocino (720) and North Fork of the Little River (658), Mendocino Co.; Eureka (906, 929), Humboldt Co.; near Hay Fork (1120), Trinity Co.; Sisson (36), Siskiyou Co. Collected at Mendocino also by Dr. Bolander and in Marin County by Professor Underwood (June, 1888).

Dr. Spruce,* in describing the dioicous *Lepidozia Pearsoni*, in which the androecia normally terminate lateral branches, has stated that in *Lepidozia reptans* the male spike always occupies a postical branch. The Californian specimens of *Lepidozia reptans*, however

* Jour. Bot. **19**: 35. 1881.

—though apparently always autoicous—occasionally show an antheridial spike at the end of a lateral branch, and we have observed the same conditions in certainly autoicous plants of G. & R. Hep. Eur. 282.

Lepidozia filamentosa * (Lehm. & Lindenb.) Lindenb.—a very distinct species, now certainly known only from Alaska—will probably yet be found to extend farther down the coast, though we are inclined to doubt its occurrence within the limits of California. This species is larger in all its parts † than *Lepidozia reptans* and more rigid and brittle in drying. The main stems are 2–3 cm. long and .36–.65 mm. in thickness. The leaves are almost transversely inserted and erecto-patent to suberect; the underleaves are proportionally larger than in *L. reptans*, being $\frac{2}{3}$–$\frac{4}{5}$ the size of the lateral leaves; the fronds have therefore the appearance of being almost uniformly developed on all sides instead of being distinctly dorso-ventrally flattened. Fig. 4 in Lindenb. & Gottsche's plates scarcely does justice to the similarity in size of the leaves and underleaves; and Taylor's "stipulis minutis" of "*Lepidozia attenuata*" is difficult to understand in view of the undoubtedly authentic original specimen existing in his herbarium, which is an exact counterpart of the original of *Jungermannia filamentosa*, now preserved in the Natural History Museum of Vienna. In the original of *L. filamentosa* the perianths are 4–6 mm. long and are widest at the middle or a little above; the only capsule seen is 2 mm. long. Menzies was probably the first collector, though his name is not cited by Lindenberg and does not appear on the Vienna specimen. The species has since been collected, so far as we know, but twice: by J. M. Macoun, Prince of Wales Sound, Alaska, September, 29, 1891 (no. 389, associated with *Scapania Bolanderi*, in herb. Underwood), and by Miss Jessie Trowbridge, Sumdum, Alaska, 1895 (in herb. Howe). The species is apparently dioicous. We have seen perianths only upon the original specimen. The androecia are upon ventral branches. The main stems and lateral branches (especially

* LEPIDOZIA FILAMENTOSA Lindenb. (excluding var. β?); G. L. & N. Syn. Hep. 206. 1845. Lindenb. & Gottsche, Sp. Hep. fasc. 6 & 7: 36. *pl. 6.* 1846.
Jungermannia filamentosa Lehm. & Lindenb.; Lehm. Pugill. 6: 29. 1834.
Lepidozia attenuata Tayl. Lond. Jour. Bot. 5: 369. 1846.

† With the exception of the leaf-cells, which are a trifle smaller and more opaque

in ♀ plants?) sometimes terminate in a somewhat enlarged, rather dense, rosette of leaves.

Lepidozia humillima Tayl. (*l. c.*) "Northwest coast of America? Menzies" is a *Cephalozia.*

29. BLEPHAROSTOMA Dumort. *p. p.* Rec. d'Obs. Jung. 18. 1835. Spruce, On Cephalozia, 86. 1882.

Jungermannia § *Blepharostoma* Dumort. *p. p.* Syll. Jung. 65. 1831.

Chaetopsis Mitt. Jour. Linn. Soc. **8**: 53. 1865.

Blepharostoma § *Chaetopsis* Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. 1^3: 104, 105. 1895.

Plants small, sometimes very slender and delicate. Stems usually prostrate-entangled, the branching normally lateral or subdichotomous. Leaves transversely inserted, divided very nearly or quite to the base into 2–5 rigid and setaceous or soft and capillary, simple or less commonly furcate laciniae, each consisting of a single row of cells throughout. Underleaves very similar, their laciniae sometimes fewer by one and occasionally a little shorter. Archegonia few, terminal on the main stem or on the principal branches. ♂ bracts usually more crowded than the leaves, their laciniae sometimes more numerous and often forked; antheridia ovoid, solitary or very rarely binate. ♀ bracts gradually larger than the leaves, free from the perianth, distinct or the inmost slightly connate at the base, the often much branched laciniae springing from a basilar membrane several cells in height; bracteoles similar. Perianth subpyriform to elongate-cylindrical, its wall composed of a single layer of cells, the mouth ciliate. Capsule dehiscing to the base by four straight valves. Seta rather short or moderately long. Elaters bispiral, obtuse.

Key to the Species.

Leaves mostly with 3 or 4 laciniae, their cells 40–70 $\mu \times$ 16–32 μ, 1½–2½ times as long as broad, thick-walled, the septa usually strongly thickened toward the periphery and slightly protuberant. 1. *B. trichophyllum.*

Leaves mostly with 2 or 3 laciniae, their cells 50–112 $\mu \times$ 25–50 μ, 1½–4 times as long as broad, thin-walled, slightly contracted at the septa (which are never at all protuberant). 2. *B. arachnoideum.*

1. BLEPHAROSTOMA TRICHOPHYLLUM (L.) Dumort. Rec. d'Obs. Jung. 18. 1835.

Jungermannia trichophylla L. Sp. Pl. 1135. 1753.

Chaetopsis trichophylla Mitt. Jour. Linn. Soc. **8**: 53. 1865.

Green or yellowish-green, intricately caespitose or straggling among other bryophytes: stems rather rigid, 4–20 mm. long, .06–.27 mm. in diameter, with often copious lateral or dichotomous branching, cortical cells subopaque, 7–14-seriate, 28–96 μ × 15–32 μ, axile cells 4–12-seriate; root-hairs infrequent: leaves close or somewhat widely spaced, erecto-patent or suberect, divided nearly to the base into 3 or 4 rigid setaceous laciniae (occasionally five or in very slender conditions rarely reduced to two), these .4–.65 mm. (8–13 cells) long, usually connate for ½–¾ the height of the basal cells, or sometimes with a basilar membrane one cell in height; leaf-cells 40–70 μ × 16–32 μ, 1½–2½ times as long as broad, thick-walled, the septa usually strongly thickened toward the periphery and slightly protuberant, giving the laciniae a somewhat nodulose outline; cuticle granulate or striatulate: underleaves similar to the lateral leaves, their laciniae commonly one or two cells shorter: paroicous, or with antheridia on the same axis but a little removed from the ♀ bracts, or sometimes dioicous: ♂ bracts with a narrow basal membrane, the laciniae usually once furcate; antheridia about .15 mm. in diameter, the short stalk composed of a single row of cells: archegonia 4–7: ♀ bracts 4–6-laciniate with a basilar membrane 2–6 cells high, the laciniae furcate or often with an antler-like ramification: perianth highly exserted, cylindrical or pyriform-cylindrical, 1.5–2.2 mm. × .45–.8 mm., inflated, with usually one or two deep furrows toward the apex, the rather wide mouth somewhat abruptly drawn together and fringed with long, mostly connivent cilia: calyptra thin, free, about half as long as the perianth: capsule ellipsoid-oval, .6–.9 mm. long, the valves bistratose, the cell-walls of the outer layer with purplish-brown columnar thickenings, those of the inner layer with similar thickenings and with imperfect semiannular fibers; seta 5–12 mm. long; foot deeply penetrating the stem-apex, descending to the plane of insertion of the third set of bracts; spores 14–18 μ, minutely granulate-papillate; elaters 130–300 μ × 9–11 μ.

On logs and moist soil.

Fish Creek, Mariposa Co. (Miss Edith S. Byxbee, July, 1895); near Mendocino (668, 722); Blue Lake, Humboldt Co. (1009).

2. **Blepharostoma arachnoideum** sp. nov.

Pallid or yellowish-green, depressed-caespitose, very delicate, confervoid, mostly pulverulent-nitent owing to the presence of gemmae: stems flaccid, 2–5 mm. long, .05–.22 mm. in diameter, simple or sparingly branched, the branching dichotomous, lateral, or sometimes strictly ventral, cortical cells 4–10-(mostly 6- or 7-) seriate, pellucid, 48–160 μ × 25–60 μ, the dorsal a little larger

than the ventral, axile cells 1–6-seriate; root-hairs very long, colorless or yellowish, usually wanting, springing, when present, singly or in groups of 2 or 3 from near the places of insertion of the underleaves: leaves rather widely spaced, patent or erecto-patent, divided nearly or quite to the base into 2 or 3 capillary laciniae (very rarely four, or in attenuate conditions sometimes reduced to one), the laciniae .36–.75 mm. (6–11 cells) long, often once forked at about the middle or above, discrete to the very base or more commonly connate for ¼–½ the height of the basal cells, slightly contracted at the septa; leaf-cells mostly 50–112 μ × 25–50 μ, 1½–4 times as long as broad, hyaline, thin-walled, the septa sometimes slightly thickened toward the periphery but never at all protuberant; cuticle (of the cortical cells as well) minutely striatulate: underleaves very similar in all respects to the lateral leaves: gemmae frequent, especially toward the stem-apex, unicellular, oblate-ellipsoidal, 25 μ in greatest diameter, formed by the multiplication in a single series and reduction in length of the terminal cells of the leaf-segments, the resulting submoniliform chains composed often of 12–18 cells: remaining parts unknown.

On old logs in moist woods, "Russian Gulch," near Mendocino (703—the type) and North Fork of the Little River (1222), Mendocino County.

The above species is strikingly distinct from *Blepharostoma trichophyllum*. *Blepharostoma sejunctum** Ångst., from Brazil, is doubtless a nearer ally, judging from description alone, but the Californian plant evidently differs from this in the shorter and rather stouter stems, in having often 3 leaf-laciniae, the basal cells of which are commonly more or less connate, in the broader leaf-cells, and probably also in the ramification. In habit and delicacy of structure, *Blepharostoma arachnoideum* is suggestive of Dr. Spruce's genera *Telaranea* and *Arachniopsis*. The occasional occurence of a postical branch is an aberrant character in *Blepharostoma*, with which genus, however, the equally developed three ranks of leaves plainly unite our plant. The species, in a sense, connects *Blepharostoma* with *Telaranea*, which, in turn, as Spruce remarks, is with difficulty kept separate from *Lepidozia*.

* Öfvers. Kongl. Vetensk.-Akad. Förhandl. 1876[7]: 78. 1876. The width of the laciniae is here given as "0,003 millim." which is evidently a misprint for 0,03 millim.

30. ANTHELIA Dumort. *p. p.* Rec. d'Obs. Jung. 18. 1835. Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. 1^3: 106. 1895.

Jungermannia § *Anthelia* Dumort. *p. p.* Syll. Jung. 63. 1831. *Anthelia* § *A.* Spruce, On Cephalozia, 80. 1882.

Plants small, densely caespitose, olivaceous-green or glaucescent.* Stems stout for the size of the plant, opaque, irregularly pinnate, the branches all lateral, cortical cells multiseriate, small to medium-sized; root-hairs few or abundant. Leaves small, transversely inserted, erect or erecto-patent, somewhat complicate-carinate, commonly equitant-imbricate, bifid to the middle or below, the lobes subacuminate, several cells in width except at the extreme apex, the margins entire or erose-denticulate. Underleaves similar to the lateral and scarcely smaller, the stems, therefore, appearing uniformly tristichous-foliate. Dioicous or paroicous. Antheridia large, solitary in the axils of but slightly modified leaves. Archegonia few, terminal on the main stem or the leading branches. ♀ bracts gradually larger than the leaves, densely crowded, more often denticulate, more or less fused with the base of the perianth and the hollowed-out stem-apex, distinct or rarely somewhat connate at base, the apices commonly hyaline. Perianth ovoid to short-cylindrical, deeply unisulcate dorsally and 2- or 3-carinate ventrally, 8–10-plicate at the slightly narrowed lobate-dentate mouth, the wall of 2 or 3 layers of cells near the base, otherwise unistratose. Calyptra 2 or 3 cells thick, carrying on its surface the sterile archegonia and sometimes also small scale-like paraphyses. Capsule subglobose, dehiscing to the base by straight valves, which are composed of two layers of cells, the walls of the outer layer with columnar or nodular thickenings, those of the inner layer similarly marked toward the base of the capsule but bearing toward the apex more or less perfect semiannular fibers; seta short. Elaters 2- or 3-spiral.

1. ANTHELIA JURATZKANA (Limpr.) Trevis. Mem. r. Ist. Lomb. III. **4**: 416. 1877. Spruce, On Cephalozia, 82. 1882.

Jungermannia Juratzkana Limpr.; Cohn, Krypt.-Fl. Schles. **1**: 289. 1877. Hedwigia, **15**: 18. 1876.

* Herbarium specimens of *Anthelia* are often thickly covered with a delicate white cobwebby growth, which under a magnification of 500 diameters is found to consist of very slender short and rigid or long and flexuous threads about 1 μ in diameter and of homogeneous structure. The organism is evidently one of the colorless schizophytes, but further than this we would not attempt to express an opinion as to its systematic position. Schizophyceae and mycelia of fungi are usually also present in greater or less abundance.

(?) *Jungermannia nivalis* Sw.; Wahlenb. Fl. Carp.* 363. 1814. Wahlenb. Fl. Suec. 779. 1826.

Anthelia nivalis Lindb. Musc. Scand. 5. 1879. Kaalaas, Nyt Mag. for Naturvidensk. **33**: 232. 1893.

Plants dark green or glaucescent at the apices, brownish below, forming wide dense mats 2–4 mm. in thickness: primary stems prostrate or decumbent, the principal branches erect, .08–.26 mm. in diameter, sparingly radicelliferous; leaves erect-appressed, usually crowded, more distant on slender sterile stems, ovate, .3–.35 mm. long, bifid ½–¾ their length, the lobes ovate-lanceolate, subacuminate, the margins entire or very slightly erose-denticulate; leaf-cells rectangular-oblong to subquadrate, 16–40 μ in greatest diameter, rather thin-walled: paroicous: bracts several pairs, a little saccate at base, apices denticulate, bracteoles similar: perianth scarcely exserted, ovoid, 1–1.6 mm. × .6–.7 mm., lobulate at the somewhat contracted mouth: capsule .5–.7 mm. in diameter, on a seta 1–3 mm. long; spores 16–24 μ in maximum diameter, granulate-papillate; elaters 120–175 μ long, 11–14 μ in greatest diameter, somewhat attenuate at the extremities, mostly trispiral.

On rocks in alpine regions. "California, Bolander" in herb. U. S. National Museum (under the name *Anthelia julacea*). It seems probable that Dr. Bolander's specimen was collected on Mt. Dana in September, 1866.

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* This citation is as given by authors. We have been unable to consult this earlier work of Wahlenberg's and have also failed to see the "W. M. Ind. musc." in which *Jungermannia nivalis* as a *nomen nudum* is said to have made its first appearance. Though we have not been able to see all the literature bearing upon the point, we are of the opinion that *Jungermannia nivalis* Sw. should be treated as an exact synonym of *Jungermannia julacea* Lightf., inasmuch as we are in possession of no evidence (as has already been said, in effect, by Dr. Spruce) that Lightfoot, Swartz, or Wahlenberg distinguished between what we now recognize as *Anthelia julacea* and *Anthelia Juratzkana*. *Jungermannia nivalis* could then be cited as a synonym for *Jungermannia julacea*, in the restricted sense of Limpricht, with as much justice as for *Jungermannia Juratzkana*. At all events, in Wahlenberg's Flora Suecica, *Jungermannia nivalis* is used in contradistinction to *Jungermannia julacea* which is applied to the *Jungermannia concinnata* of Lightfoot and of Hooker, and the diagnosis of *Jungermannia nivalis* as there given, would, on the whole, ("*surculis setaceis ramosis*;" "*surculi* * * * *flexuosi*") be more suggestive of the dioicous species. Lindberg, it is true states (Kongl. Sv. Vet. Akad. Handl. 23^5: 29. 1889) that his *Anthelia nivalis* (the paroicous species) is very common in Scandinavia while *A. julacea* is very rare, but Kaalaas (Nyt Mag. for Naturvidensk. 33: 230, 231, 233, 234. 1893) finds the two species about equally abundant in Norway. Until proof is forthcoming that *Jungermannia nivalis* was originally applied to the paroicous species we prefer, with Spruce, to use a specific name concerning whose original meaning there is no doubt.

Anthelia julacea (L.; Limpr.) Dumort.—a nearly related species, which may be expected to occur in California—is distinguished by its larger size, dioicous inflorescence, thicker-walled leaf-cells, and bispiral elaters.

31. PTILIDIUM Nees, Naturgesch. Eur. Leberm. **1**: 95. 1833.
Blepharozia Dumort. Rec. d'Obs. Jung. 16. 1835.

Usually in dense and commonly brownish mats. Stem prostrate or ascending, 1–2-pinnate or irregularly and sparingly branched, eflagelliferous, the branches lateral; root-hairs few and short. Leaves obliquely inserted, twice bifid to below the middle or palmately 3–5-cleft, the dorsal segments larger and incubous, all filiform-acuminate, the segment-margins entire, or more commonly fringed with long, simple or branched cilia. Underleaves much smaller but otherwise somewhat similar, more or less distinctly 2- or 3-parted. Antheridia short-stalked, on the main stem or lateral branches, in the axils of more concave and more closely imbricate but otherwise scarcely modified leaves. Archegonia terminal on what is primarily the main stem or a principal branch, the perianth, however, through innovation below, finally apical on a short apparently lateral or dichotomously divergent branch. Bracts commonly one or two pairs, similar to the leaves or often more profusely ciliate-laciniate. Perianth free, several times longer than the bracts, cylindrical-obovate, ciliate and subplicate at the somewhat contracted mouth. Calyptra free. Capsule ovoid on a moderately long seta, dehiscing to the base by four rather rigid valves, the cells of the latter bearing semiannular and also brownish nodular thickenings. Spores punctulate, several times broader than the 2- (3-) spiral elaters.

1. PTILIDIUM CALIFORNICUM (Aust.) Underw. & Cook, Hep. Am. 69. May, 1890. Pearson, List Can. Hep. 7. 16 Je. 1890.

Lepidozia ? Californica Aust. Bull. Torr. Bot. Club, **6**: 19. 1875.

Mastigophora Californica Aust. Bull. Torr. Bot. Club, **6**: 302. 1879.

Brownish or greenish-yellow, usually in dense appressed mats: stems subfiliform and flaccid or becoming somewhat stout, mostly 2–3 cm. long, irregularly and sparingly branched, rarely subpinnate or subbipinnate: leaves loosely imbricate, palmately 3- or 4-cleft to below the middle, the segments lanceolate or more commonly linear-lanceolate, filiform-attenuate, unequal, the ventral

smaller and subinflexed, the segment-margins very entire, repand, or here and there again incised or sometimes bearing a few (2 or 3 on a side) long and rather rigid cilia: underleaves usually a little broader than the stem, deeply 2- or 3-parted, the segments inciso-ciliate; leaf-cells 40–45 μ, hexagonal- or pentagonal-rotund, the walls strongly thickened at the angles, cuticle smooth: dioicous: ♂ plants commonly more slender, androecium cauline or rameal, antheridia ovoid or ellipsoidal, single or in pairs, the stalks finally much shorter than their long diameter: ♀ branch short, bearing about 2–4 pairs of leaves inclusive of bracts: bracts one or two pairs, a little larger than the leaves and more inciso-ciliate; bracteole similar, rarely connate with bracts on one or both sides; perianth cylindrical-obovoid to subfusiform-oblong from an obconic base, slightly narrowed at the ciliate subplicate mouth: spores brown, 21–30 μ; elaters 120–225 $\mu \times 7$–10 μ, 2- (rarely 3-) spiral, contorted, subobtuse.

Found in California only by its first collector, Dr. Bolander. The plants from which the original description was drawn were picked out from specimens of *Hypnum circinale* in Sulliv. & Lesq. Musc. Bor.-Am. Exsicc., No. 474, ed. 2; these are now preserved in herb. Pearson. Duplicates of this original material may often be found in connection with no. 474 of the Exsicc. cited. Habitat and locality were given as "ad corticem arborum in sylvis Californiae montanae." The specimens doubtless came from Humboldt or Mendocino counties, and the plant is to be looked for on the bark of living trees and fallen trunks of *Sequoia sempervirens* and of other conifers in the northern coast region. The species extends northward to British Columbia (Macoun) and to Idaho (Leiberg). Some of the northern specimens make a nearer approach to *Ptilidium ciliare*, which also occurs in the same region, but are always very distinct in the less branched stem, the more rigid leaves, with much more pronouncedly filiform-attenuate segments and longer, more rigid, and always much less numerous cilia.

PLATE 105. PTILIDIUM CALIFORNICUM.

1. Plants, natural size.
2. Portion of stem, with branch, × 12.
3. Cauline leaf, viewed from above, × 23.
4. Cauline leaf, viewed from below, × 23.
5. A 3-cleft cauline leaf, viewed from below, × 23.
6. A typical apex of leaf-segment, × 41.
7. Cauline leaf, ventral view, × 23.

8. Rameal leaf, ventral view, ×23.
9 and 10. Underleaves, ×23.
11. Androecium, × 12.
12. ♂ bract, × 23.
13. Antheridia, × 23.
14. Bracteole, × 23.
15. Second (next to the inmost) bracteole from another plant, × 23.
16. Inmost bract, × 23.
17 and 18. Ventral and dorsal aspects of perianth and bracts, × 12.
19. Portion of perianth-mouth, × 41.
20. Leaf-cells, × 225.

Figs. 1–6, 9, 10, and 20, drawn from the type specimen collected in California by Bolander, ex. herb. Pearson; the remaining figures from Hep. Am. 69 (Idaho, J. B. Leiberg).

32. SCAPANIA Dumort. Rec. d'Obs. Jung. 14. 1835.

Martinellius S. F. Gray, *p. p. max.* Nat. Arr. Brit. Pl. 1: 690. 1821. Lindb. (as *Martinellia*) Act. Soc. Sci. Fenn. 10: 518. 1875. O. Kuntze (as *Martinellia*), Rev. Gen. Pl. 837. 1891.

Radula Dumort. *p. p.* Comm. Bot. 112. 1822.

Radula § *Scapania* Dumort. Syll. Jung. 38. 1831.

Plants usually large, caespitose, green, brown, rose-red, or dark-purple; primary stems defoliate, creeping, the secondary mostly ascending, sometimes erect, rarely prostrate, simple or dichotomously branched, apex commonly decurved. Leaves alternate, distichous,* complicate-bilobed, the fold rounded outwardly or more often with an acute or somewhat winged keel, margins of the lobes ciliate, dentate, or entire; ventral lobes mostly larger, convex dorsally, succubous; dorsal lobes incumbent; underleaves wanting. Stem-apex and upper leaves sometimes gemmiferous. Dioicous or rarely monoicous; androecium terminal or interrupted; ♂ bracts ventricose, usually smaller and with subequal lobes; antheridia (mostly 1–6) ovoid or ellipsoidal, on pedicels of about their own length, often accompanied by hair-like or leaf-like paraphyses. Archegonia few, at the apices of the main branches. ♀ bracts hardly different from the ordinary leaves, though a little larger and more equally lobed. Perianth oblong or obovate, strongly compressed dorso-ventrally (parallel with the plane of the stem), smooth, or rarely subplicate, the mouth broad, truncate, entire, dentate, or ciliate, decurved when young. Capsule oblong-ovoid, long-exserted, valves thick-walled, the inner layer of cells with semiannular or nodose thickenings. Elaters bispiral, deciduous.

* See *Scapania heterophylla.*

Key to the Species.

Uppermost leaves (in ♀ plants) with long curved teeth on the carina; perianth-mouth denticulate or subentire. 3. *S. Oakesii.*

Leaves without teeth (or very rarely a single tooth) on the carina or fold.

Basal margin of dorsal leaf-lobes with long, decurved, often compound cilia; leaves coarsely dentate; ventral lobes oblong-ovate. 1. *S. Bolanderi.*

Basal margin of dorsal leaf-lobes entire or with small teeth.

Plant ("frond") distinctly complanate; leaves always distichous.

Stems 4–15 mm. long; ventral leaf-lobe very slightly or not at all decurrent.

Leaves bilobed ½–⅔ their length; ventral lobes oblong-ovate, acute or subacuminate, serrate-dentate, deflexed and often somewha. secund; dorsal lobes nearly parallel to the stem, appressed-imbricate above; perianth-mouth entire or repand. 5. *S. umbrosa.*

Leaves bilobed ½ their length; ventral lobes orbicular-ovate to obovate, often obtuse, entire or sparingly dentate; dorsal lobes erecto-patent or patent-horizontal, ascending, never appressed-imbricate; perianth mouth in most cases shortly ciliate-dentate. 6. *S. curta.*

Stems 1–10 cm. long, ventral leaf-lobe decurrent, obtuse, rarely subacute.

Plants aquatic; leaves flaccid, lobes often subequal at apex, sometimes entire, the ventral round-trapezoidal; perianth-mouth repand or subdentate. 4. *S. undulata.*

Plants non-aquatic; leaves somewhat stiff, ciliate-dentate; ventrat lobes obovate, 2–2½ times the size of the dorsal; perianth-mouth ciliate-dentate. 2. *S. nemorosa.*

Plant ("frond") obscurely complanate; leaves sometimes irregularly 3-ranked by interpolation of unlobed leaves, erecto-patent, often with squarrose tips. 7. *S. heterophylla.*

SCAPANIA BOLANDERI Aust. Proc. Acad. Nat. Sci. Philad. 1869: 218. 1869.

Scapania caudata Tayl. in herb.

Scapania Californica Gottsche; Cal. Med. Gaz. 1870: 184 (10) (name only). 1870.

Scapania albescens Steph. Bot. Jahrb. 8: 96. 1886.

Olive-green to yellowish-brown, caespitose: stems rigid, ascending, nearly prostrate or subpendulous, 1–4 cm. long, dichotomous, ♀ plant innovating from near base of the perianth: leaves scarcely increasing in size upward, approximate or close, stiff, hardly changed in form or position on drying, acutely complicate, narrowly alate-carinate, the carina entire or rarely furnished with a single tooth; ventral lobes obliquely oblong-ovate, patent, strongly convex, obtuse, slightly decurrent, coarsely dentate, 2½ times greater than the dorsal, apex and ventral margin reflexed; dorsal lobes broadly and obliquely ovate, more or less

imbricate, erect or subappressed, slightly convex, somewhat acute, with fewer and larger teeth and bearing at the base several long decurved often compound cilia; leaf-cells subquadrate-oval, more elongated toward base, 15–40 μ, with conspicuous trigones, cuticle minutely roughened: gemmae at apex of stem, of one or two cells, oval or ellipsoidal, 15–25 $\mu \times 15$ μ: dioicous, ♂ and ♀ plants in the same tuft: androecium terminal or often interrupted; antheridia 2–6, ellipsoidal or obovoid, on stalks of about their own length or longer, accompanied by very numerous, branching, capillary, or leaf-like paraphyses; ♂ bracts scarcely modified or smaller, saccate, densely imbricate, with subequal incisodentate lobes: perianth oblong, more rarely obovate, 2–3.5 mm. × 1.5–1.8 mm., ciliate-lacinulate or doubly ciliate-dentate at mouth: capsule oblong-ovoid, brown, seta 3–10 mm. long; spores 10–12 μ, punctulate; elaters bispiral, obtuse, contorted, 100–175 $\mu \times 8$–10 μ.

Exsicc. Hep. Bor.-Am. 19.

Common in the Coast Range Mountains, north of San Francisco, on logs and stumps of the Coniferae, especially of *Sequoia sempervirens*—more rarely on the bark of living trunks.

Redwood Cañon, Marin Co. (Miss Edith S. Byxbee); Duncan's Mills (1193) and Turner's Cañon (1194), Sonoma Co.; Mendocino (596), Little River (648, 684), and Half-Way House (727), Mendocino Co.; Eureka (911, 928, 938, 984), Humboldt Co. Frequently with sporogonia. Apparently closely confined to the Pacific Coast, ranging as far northward as Alaska. Specimens from Nova Scotia, Ontario, and Lake Superior, referred to this species by Mr. Pearson * are probably something else. *Scapania Bolanderi* is strongly marked by the rigid oblong-obovate ventral lobes and by the coarsely dentate dorsal lobes, furnished at the base with long curved often branched cilia. These cilia often lie close to the stem and are covered by the dorsal lobe next below, so that a careful separation of the leaves from the stem is usually necessary for a satisfactory demonstration of this character.

The plant when growing in tufts of *Dicranum* is sometimes erect. We have rarely met with gemmiferous conditions. The original specimens were collected in California by Dr. Bolander, and were distributed by Mr. Austin as no. 19 of the Hepaticae Boreali-Americanae.

* List of Can. Hep. 13. 1890.

Unpublished figures of this species, drawn by Dr. Gottsche, are preserved in the Gray Herbarium at Cambridge, Mass. The sheet on which the figures are drawn bears the inscription "Scapania Californica G. MS.," in addition to the name given the species by Mr. Austin.

Scapania Bolanderi is reported from Japan by Herr Stephani, (Bull. Herb. Boiss. **5**: 82. 1897).

PLATES 106 AND 107. SCAPANIA BOLANDERI.

1. Plants, natural size.
2. Apical portion of a sterile plant, × 12.
3. Portion of a ♂ plant, showing position of androecia, × 12.
4. Ciliate margin of the base of the dorsal lobe, × 106.
5. Apex of ventral lobe, × 106.
6. Leaf, dorsal view, × 23.
7. Leaf, ventral view, × 23.
8. Young perianth and bracts, ventral view, × 12.
9. Perianth, bracts, and sporogonium, × 12.
10 and 11. ♂ bracts and antheridia, × 12.
12. Antheridia, × 53.
13. Antheridial paraphyses, × 106.
14. Outline of a portion of perianth-mouth, × 53.
15 Leaf cells near apex of ventral lobe, × 305.

Figs. 1, 3, and 10–12, from no. 938 (Eureka); 2, 6 and 7, from no. 984 (Eureka); 4, 5, 8, 9, 14 and 15, from no. 596 (Mendocino); 13 from no. 928 (Eureka).

2. SCAPANIA NEMOROSA (L.) Dumort. Rec. d'Obs. Jung. 14. 1835.

Jungermannia nemorosa L. Sp. Pl. **2**: 1132. 1753.

Brownish or olive-green, usually in broad, compact cushions: stems rather rigid, 1–6 cm. long, sparingly branched, ascending, with the apex more or less decurved: leaves somewhat stiff, approximate or slightly imbricate, increasing a little in size upward, irregularly ciliate-dentate, more or less evidently winged along the fold, the ventral margin decurrent; ventral lobes 2–2.5 times larger than the dorsal, obovate, convex, obtuse, apex and ventral margin commonly deflexed; dorsal lobes reniform or broadly and obliquely ovate, rounded at apex or with a short point, usually a little vaulted, the margin somewhat appressed; leaf-cells nearly uniform, oval-quadrate, thick-walled, cuticle roughened: gemmae sometimes abundant at stem-apex and on margins of upper leaves, yellowish-brown, oval, unicellular or uniseptate, 15–24 μ × 15 μ occasionally in moniliform threads: dioicous: androecium terminal, ♂ bracts scarcely different, antheridia 2–6, accompanied by numerous long, multiseptate, simple or branched, hair-like para-

physes, brown trichomes of a similar structure sometimes occurring on other parts of the stem: perianth long-obovate, 2–3.5 mm. × 1.5–2 mm., now and then subplicate, ciliate-dentate at mouth: capsule ovoid-oblong, brown, seta 5–15 mm. in length; spores 12–16 μ, punctulate; elaters contorted, 100–180 μ × 7–10 μ.

On rocks and moist banks. Mt. Tamalpais (21, ♂ and gemmiferous); Lake San Andreas (1192, *c. fr.*) San Mateo Co.; near Cazadero (1191, *c. fr.*), Sonoma Co.; Crescent City (Mr. Thomas Howell), Del Norte Co. A few slender gemmiferous plants from near Lake Lagunitas, Marin Co., appear to belong with this species also, though the dorsal lobes are commonly squarrose and the teeth are shorter and less numerous than is usual.

The cuticle in the Californian specimens is for the most part distinctly granulate or verruculose, often as much so as in a specimen of *Scapania aspera* Müller & Bernet * collected and determined by Loitlesberger and in another collected and determined by Pearson, but we are unable as yet to distinguish *Scapania aspera* from *S. nemorosa*. A specimen collected by Loitlesberger in "Saminathal (Vorarlberg) 800 m." and named by him *Scapania nemorosa* has its leaf-cells more decidedly scabrous than has either of these specimens which have been referred to *Scapania aspera*.

3. SCAPANIA OAKESII Aust. Bull. Torr. Bot. Club, **3**: 10. 1872.

Light-green, brownish, or fuscous-purple, caespitose: stems somewhat rigid, sparingly branched, ascending, 1–2.5 cm. long: leaves tense or a little flaccid, approximate or close, crowded and larger at apex in ♀ plants, alate-carinate, the carina in the upper leaves, especially the involucral, broad and furnished with a single or sometimes a double series of long, usually curved, teeth, these wanting or infrequent in ♂ plant, ventral margins decurrent; ventral lobes obliquely obovate or rhombic-trapezoidal, 2–2.5 times greater than the dorsal below, subequal at the apex, convex, obtuse or sometimes slightly pointed, serrate-dentate; dorsal lobes round-ovate, scarcely imbricate except at stem-apex, convex, obtuse or subacute, the upper often unicalcarate-dentate at basal margin, the teeth otherwise rather smaller and less numerous than in the ventral lobes: marginal and median leaf-cells quadrate-oval, 15–24 μ, oblong-hexagonal near the base, 30–56 μ × 16–18 μ, trigones inconspicuous, cuticle plainly roughened: sometimes gemmiferous at stem-apex or on margins of the upper leaves, gemmae mostly

* Bernet, Cat. Hep. du Sud-Ouest de la Suisse et de la Haute-Savoie, 42. 1888.

unicellular, spherical or oval, 15–20 μ, occasionally in branching moniliform threads: dioicous: ♂ and ♀ plants mingled or in separate tufts, ♂ plants more slender: androecium terminal, ♂ bracts smaller, approximate or rather distant, more rarely subimbricate, ventricose, lobes nearly equal, the dorsal often calcarate-dentate at base, antheridia 2–6, accompanied usually by a very few short capillary or sometimes leaf-like paraphyses: perianth oblong or obovate, truncate, denticulate or subentire at the mouth.

On moist banks. Mendocino (590, ♂); near Eureka [945, 946 (*c. per.*)] and Kneeland Prairie Road (1025), Humboldt Co.

Scapania Oakesii, as represented in Austin's Hep. Bor.-Am., no. 14, and in two other specimens from herb. Austin in herb. Underwood (all from the White Mountains of New Hampshire) is a large plant evidently very closely related to *Scapania undulata purpurea*. Our plants are usually smaller, more copiously subciliate-dentate on the carina, and have more resemblance superficially to *S. nemorosa*, yet are certainly distinct from either of the species named. They accord very closely with Dr. Scouler's specimens from Observatory Inlet, in herb. Torrey, which Austin made var. *β* of *Scapania Oakesii*. In some of the Eureka plants the carina is richly provided with teeth as far as the seventh or eighth pair of leaves from the stem-apex.

PLATES 108 AND 109. SCAPANIA OAKESII.

1. Plants, natural size.
2. Perianth and bracts, ventral view, × 12.
3 and 6. ♂ plants, × 12, the former gemmiferous at apex.
4. Apical portion of a ♀ plant, dorsal view, × 12.
5. Perianth and bracts, dorsal view, × 12.
7. ♂ bract and antheridia, × 23.
8. Antheridium, × 53.
9. Antheridial paraphyses, × 106.
10 and 11. Leaves from near the stem-apex of a sterile ♀ plant, × 23.
12. Leaf, ventral view, × 23.
13. Leaf from lower part of stem, carina entire, × 23.
14. ♀ bract, × 23.
15. Leaf-cells from near apex of ventral lobe, × 305.
16. Portion of perianth-mouth, × 53.
17. Margin of apex of ventral lobe, × 106.

Figs. 1, 3, 4, 6–13, 15, and 17, from no. 946 (near Eureka); 2, 5, and 14, from no. 945 (near Eureka); 16, from no. 1025 (Kneeland Prairie Road).

4. SCAPANIA UNDULATA (L.) Dumort. Rec. d'Obs. Jung. 14. 1835.

Jungermannia undulata L. Sp. Pl. 2: 1132. 1753. Hook. Brit. Jung. *pl. 22.* 1816.

Green, rose-red, or dark purple, rarely brownish, in compact or loose tufts: stems rather rigid, usually erect, sometimes floating, 1–10 cm. long, sparingly branched, with very few root-hairs, denudate and brittle below: leaves larger and imbricate at apex, approximate or distant below, mostly soft and flaccid, usually undulate-crisped or crumpled in drying, entire, denticulate, or ciliate-dentate, slightly alate-carinate, carina entire; ventral lobes round-trapezoidal, mostly twice the size of the dorsal, subequal toward the stem-apex, sometimes broadly pointed, decurrent, convex or nearly flat; the dorsal lobes equally broad, obliquely and broadly ovate, with a rather obtuse point, loosely incumbent or somewhat bent away from the stem: leaf-cells near the margin quadrate or oval, 15–20 μ, oblong-hexagonal in the middle, 45–60 $\mu \times$ 15–30 μ, mostly thin-walled, cuticle more or less distinctly hyaline-roughened: dioicous: perianth oblong or more rarely obovate, slightly narrowed at the entire, repand, or subdentate mouth.

On stones in streams and springs or in very moist places, especially in mountainous regions.

North Fork of the Little River, Mendocino Co., on submerged rocks (600). No. 649, from the same locality but growing on a log just above the water-line appears to be a variety approaching *S. nemorosa* in the subciliate-dentate upper leaves and in the form and relative size of the lobes, having, however, the subentire perianth mouth of *S. undulata.* No. 639, sterile, from wet rocks in stream-bed seems to agree with the latter, as does also a specimen collected in the region of the Yosemite Valley by C. M. Cooke, Jr., in 1896 (*ex dono* A. W. Evans). Also collected in California by Dr. Bolander, the exact locality unknown.

Scapania uliginosa (Sw.) Dumort., so far as we know, has not yet been collected in California, but its discovery there may be expected. It differs from *Scapania undulata* chiefly in the smaller, reniform, strongly convex dorsal lobes, much narrower than the ventral lobes and $\frac{1}{4}$–$\frac{1}{3}$ their size, and in the always entire leaves decurrent on both sides, especially long-decurrent on the ventral margin.

Scapania irrigua (Nees) Dumort. differs from *S. undulata* in the softer, weaker stems, bearing root-hairs to the apex, in the

thinner, softer, less decurrent leaves, with nearly orbicular lobes, of which the convex dorsal is ⅓–½ the size of the ventral and sharply pointed, the ventral commonly with a short point.

5. SCAPANIA UMBROSA (Schrad.) Dumort. Rec. d'Obs. Jung. 14. 1835.

Jungermannia umbrosa Schrad. Syst. Samml. Krypt. Gew. 2: 5. 1797. Schrad. Jour. Bot. 1801: 67. 1803. Hook. Brit. Jung. *pl. 24.* 1816.

Jungermannia convexa Scop. (?) Fl. Carn. 2: 349. 1772. [2d ed.]

Martinellia convexa Lindb. Musc. Scand. 6. 1879.

Scapania convexa Pearson, List Can. Hep. 15. 1890.

Yellowish-green to brown, sometimes tinged with purple, in an extended, closely appressed, usually compact stratum: stems 5–15 mm. long, branching or subsimple, ascending, decurved at apex especially when dry: leaves increasing somewhat in size upward, not decurrent, bilobed ½–⅔ their length, the fold rounded or acute, sometimes with a trace of a winged keel; ventral lobes 2–3 times larger than the dorsal, oblong-ovate, acute or subacuminate, irregularly serrate-dentate toward apex, deflexed and often somewhat secund; dorsal lobes ovate, acute, sometimes narrowly pointed, dentate, nearly parallel to the stem, appressed-imbricate, except in slender sterile conditions: leaf-cells small, roundish-oval, 12–27 μ, more elongated toward base, thick-walled, trigones distinct, cuticle minutely roughened: gemmae in dark-brown clusters at stem-apex, mostly uniseptate, oblong-elliptical, 18 × 9 μ: dioicous: androecium terminal, antheridia 1–3 in axils of smaller, saccate, nearly equal-lobed leaves, accompanied by a few short, usually septate hairs: perianth oblong, from an obconic base, 1.2–2 mm. × .6–1 mm., twice as long as the involucral leaves, often purple at base, compressed, mouth entire or repand: capsule oval-oblong, dark-brown, long-exserted; spores brown, punctulate, 10 μ; elaters 125–165 μ × 7–8 μ.

Exsicc. Hep. Am. 191.

On old logs beside shaded streams, North Fork of the Little River, Mendocino Co. (647, 683) and Eureka, Humboldt Co. (961); also on compact argillaceous soil in the first-named locality (686). No. 711, from a log in Russian Gulch, near Mendocino, which we formerly (Erythea 5: 89. 1897) referred to *Scapania glaucocephala*, we now believe to be an abortive, gemmiferous con-

dition of *Scapania umbrosa.* Collected by Professor Macoun on Mt. Mark, Vancouver Island.

Our plants appear to agree with the European in all the more important details, yet the marginal teeth of the leaves are rather larger and more numerous than in most of the European specimens examined, the cuticle less distinctly roughened, the dorsal lobes a little less closely imbricated, and the perianth is sometimes longer.

It is very probable, as was first pointed out by Lindberg,* that *Jungermannia convexa* Scop. is identical with *J. umbrosa* Schrad., though the perianths ("*thecae*") were described by Scopoli as oval, and dentate at the apex, while those of *Scapania umbrosa* are oblong, with an entire or repand mouth. We have been informed by Prof. Briosi that the Scopoli collection is not preserved at Pavia and as we have been unable to locate it, we prefer to retain for this species a name concerning the correct application of which we can have no doubts.

6. SCAPANIA CURTA (Mart.) Dumort. Rec. d'Obs. Jung. 14. 1835.

Jungermannia curta Mart. Fl. Crypt. Erlang. 148. *pl. 4. f. 24.* 1817.

Bright- to dark-green, sometimes brownish, loosely gregarious or in thin mostly inconspicuous mats: stems ascending, 4–15 mm. long, .1–.35 mm. thick, simple or innovating above: leaves rather soft, usually increasing in size toward the stem-apex, bilobed to about the middle, the fold outwardly rounded or acute, rarely with a trace of a wing; ventral lobes 2–3 times larger than the dorsal, orbicular-ovate to obovate, acute, apiculate, or obtuse, entire or sparingly dentate, patent-horizontal, slightly or not at all decurrent, a little concave ventrally; dorsal lobes deltoid- or quadrate-ovate, erecto-patent to patent-horizontal, acute, entire or slightly dentate, ascending, never appressed-imbricate; leaf-cells translucent, roundish-hexagonal, 16–36 μ, becoming oblong toward the base, the walls with small trigones, cuticle nearly smooth; gemmae in a dense cluster at the stem-apex or borne on the margins of the upper leaves, brownish or colorless, ovoid to oblong-ellipsoidal, 24 × 16 μ, simple or uniseptate: dioicous: androecium terminal, antheridia single or in groups of 2 or 3: perianth long-obovate, 1.8–3.5 × 1–1.8 mm., the mouth shortly ciliate-dentate, rarely repand.

* Musc. Scand. 6. 1897.

On a log by a stream near Sisson, Siskiyou Co. (38), in company with *Riccardia latifrons*, *Chiloscyphus polyanthus*, and *Cephalozia media*. Only a few scattered gemmiferous shoots were found, yet we feel little hesitancy in referring them to *Scapania curta*, concerning the distribution of which in America little is at present known. The specimens agree closely with Rab. Hep. Eur. 93 ("α communis, 1. forma sterilis") though the leaf-cells are somewhat larger. The gemmae are broader than is usual in European forms, judging from the specimens accessible; only in G. & R. Hep. Eur. 382, have we found anything to equal the measurements given above.

7. SCAPANIA HETEROPHYLLA M. A. Howe, Bull. Torr. Bot. Club, **25**: 183. *pl. 336*. 1898.

Plants obscurely complanate, dark green, often bleaching at apices on drying, erect or ascending, forming compact cushions: stems 4–6 cm. high from a rhizomatous base, rigid, fastigiately and subdichotomously branched, brown, becoming almost black, nearly or wholly destitute of root-hairs, denudate below, 20–30 cells in thickness: leaves scarcely increasing in size upward, sometimes smaller at the stem-apex, the upper erecto-patent, subimbricate, the lower approximate, more spreading, often with squarrose tips, all strongly undulate-crisped both when moist and when dry, bilobed to the middle or bipartite, complicate, the carina acute or somewhat rounded, but never winged, commonly bistratose toward the base near the fold, the lobes sometimes almost disunited; now and then with an unlobed leaf irregularly interpolated, most frequently in the position of an underleaf; margins of the lower leaves commonly erose, of the upper entire or sparingly denticulate; ventral lobes twice as large as the dorsal or subequal, 1.7–2.5 mm. in length, .85–1.6 mm. in maximum width, broadly obovate, elliptical, or obovate-oblong, usually decurrent, mostly rounded-obtuse at apex; dorsal lobes obtuse, obliquely and broadly ovate or elliptical, not decurrent, sometimes appressed at stem-apex, especially on the younger shoots, but mostly ascending or slightly squarrose-reflexed: leaf-cells generally opaque, with smooth or slightly roughened cuticle, near the margin subquadrate or roundish-hexagonal, 16–28 μ, near the base oblong, 60–90 μ × 25–30 μ; trigones indistinct or wanting: remaining parts unknown.

Exsicc. Hep. Am. 192.

On submerged stones in a cold mountain stream (alt. 3000 ft.)

in company with *Chiloscyphus polyanthos rivularis* and *Porella rivularis*, Sisson, Siskiyou Co., July, 1894 (no. 34).

The stream, which is formed by a great spring beside the railway track about three fourths of a mile north of the village of Sisson, is said to maintain nearly a uniform volume throughout the year, and as plants were found wholly under water in the last of July and the first of August, it is probable that their submersion is permanent.

The above species was referred at first, uncritically, to *Scapania undulata* and listed under that name in Erythea (4 : 49. 1896). From *S. undulata*, however, it is certainly very distinct in the obscurely complanate branches, in the sometimes 3-ranked, often more deeply lobed, erecto-patent, never alate-carinate, leaves, with more or less squarrose tips, and in the obovate rather than round-trapezoidal ventral lobes. The interpolated unlobed leaves stand sometimes in about the general position of dorsal or ventral lobes, but more often squarely subtend the ventral surface of the stem. They can doubtless be explained in some cases, from the point of view of ontogeny, by the separation of the normally united lobes, but in other cases this hypothesis seems to find little justification. We have noticed one or two *three*-lobed leaves out of hundreds examined and in such the complete disjunction of the most ventral lobe would have thrown it nearly into the place of an underleaf. When the leaf-lobes are subequal it is often difficult to distinguish between the dorsal and ventral aspects of the stem, especially if further confused by the presence of the supernumerary entire leaves. From stems of such a character as this, however, may spring young shoots in which the leaves are regularly distichous and acutely complicate, in the ordinary *Scapania* fashion, with the ventral lobes twice the size of the dorsal. In the axils of the upper leaves are sometimes to be found numerous short clavate paraphyses, unicellular or of two or three oblong cells in a lineal series.

We are indebted to Herr K. Loitlesberger for pointing out (*in lit.*) that the leaves of our plant are "two cells thick in the middle," a texture which he has never found in submerged *Scapania undulata*.

It is possible that the species deserves to be separated generically from *Scapania*, but in absence of perianth and sporogonium, we can do no better than refer it to a genus with which it surely has very much in common.

PLATE 110. SCAPANIA HETEROPHYLLA.

1. An entire plant, ½ the natural size.

2 and 3. Opposite views of a portion of the stem, showing the often three-ranked leaves, × 15.

4. Dorsal view of stem and leaves, × 15.

5. Ventral view of the same object, showing an unlobed underleaf, × 15.

6. The leaf with lobes "a" and "a¹" already shown in figures 4 and 5.

7. A typical underleaf, × 15.

8. Outline of a deeply lobed leaf, × 15.

9. Apex of a branch of the same plant from which figures 4 and 5 were drawn; leaves here distichous, × 15.

10. The leaf "d" from the foregoing, × 15.

11. Ventral view of a leaf, × 15.

12. Cells from near base of leaf, × 244.

13. Cells from the apical margin of one of the upper leaves, × 244.

14. Paraphyses from axils of leaves, × 244.

15 Cross-section of the stem, × 32.

33. RADULA Dumort. *p.p.* Comm. Bot. 112. 1822.

Martinellius S. F. Gray, *p.p.* Nat. Arr. Brit. Pl. 1 : 690. 1821.

Stephanina O. Kuntze,* Rev. Gen. Pl. 839. 1891. Schiffn.; Eng. & Prantl, Nat. Pflanzenfam. 1³: 113. 1895.

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* Dr. Otto Kuntze evidently errs somewhat in asserting that the original *Radula* of Dumortier (1822) was an equivalent of the *Martinellius* of S. F. Gray (1821), inasmuch as Gray's *Martinellius* contained a fourth generic element, viz., the *Adelanthus* of Mitten (*Martinellius decipiens* S. F. Gray), which did not appear in the original *Radula*, even though it was given a place in the *Radula* of 1831. Now, by the "method of residues"—which seems to us a natural and logical mode of settling the descent of names originally applied to generic composites—it is clear that after Dumortier, under the name of *Radula*, had removed the modern *Radula*, *Scapania*, and *Plagiochila* elements from Gray's tetrameric genus *Martinellius*, the *Adelanthus* component was left, which would thus fall heir to the name imposed by Gray. This would seem to us a particularly happy circumstance in view of the fact that the later name *Adelanthus* was earlier used in a different sense by Endlicher. Again, by the "method of residues," the name *Radula*, after the excision in 1833 and 1835 of the *Scapania* and *Plagiochila* elements from the *Radula* of 1822, descends to the genus which has borne the name *Radula* with nearly every hepaticologist since 1833. By "priority of place," too, the name *Radula* would descend in the same way inasmuch as *R. complanata* was always the first species mentioned by Dumortier and was apparently always more or less clearly in his mind as the type of the genus. But the general application of the "priority of place" principle would result in attaching S. F. Gray's name *Martinellius* to this same species as has already been pointed out by Dr. Carrington and others.

The use of *Radulum* by Fries in 1825 for a genus of fungi cannot disqualify Dumortier's *Radula* of 1822. If either name should disappear, it is the *Radulum* of Fries.

Plants moderately large, rarely small and slender, green or yellowish-green, tinging the water a yellowish-green when soaked out, in most species creeping and forming at length wide depressed mats. Stems rather loosely pinnate or subbipinnate, very rarely dichotomous; the branches infrafoliar in origin. Leaves alternate, incubous, conduplicate-bilobed, the lobes mostly very entire, the ventral lobe smaller, often somewhat inflated near the fold, its free margin nearly always appressed to the dorsal lobe; leaf-cells small, chlorophyllose, often containing "oil-bodies." Root-hairs always springing from a mammilliform outpocketing of the ventral lobe near its base. Underleaves everywhere wholly wanting. Mostly dioicous, in a few species paroicous or autoicous. Androecia in dioicous species amentiform, usually terminal on main stem or the principal branches; the ♂ bracts 3–35 pairs, equitant, with subequal lobes; antheridia single or less commonly in 2's or 3's. Archegonia several, acrogenous, very rarely cladogenous, the matured perianth sometimes pseudolateral through the development of a "subfloral" innovation. ♀ bracts a single pair, often a little smaller than the leaves, the somewhat enlarged ventral lobe without root-hairs. Perianth in most species strongly compressed dorso-ventrally, in a few subterete, very rarely carinate or plicate, the mouth broad from the beginning, somewhat bilabiate, the truncate lips entire or repand-crenate. Calyptra narrowly obovoid or elongate-pyriform, rather firm and subopaque, its walls composed of 2 or 3 layers of cells.

Capsule mostly oval-cylindrical, 2–3 times as long as broad, 4-valved to the base, the valves bistratose, the longitudinal walls of the exterior cells with moniliform or nodular thickenings, the much thinner interior cells usually with delicate transverse striae. Seta short and stout. Spores large, subglobose or ellipsoidal, minutely granulate-papillate or subechinulate. Elaters long and slender, obtuse, closely spiral.

Key to the Species.

Dioicous; androecia linear, amentiform; dorsal leaf-lobes obovate, the inner margin adnate to stem, not surpassing it, leaf-cells 9–16 μ; spores subglobose or ellipsoidal, 48–60 μ in maximum diameter. 1. *R. Bolanderi.*

Paroicous; dorsal leaf-lobes quadrate-orbicular, the inner margin surpassing the stem, leaf-cells 16–24 μ; spores subglobose, 30–38 μ. 2. *R. complanata.*

1. RADULA BOLANDERI Gottsche; Steph. Hedwigia, **23**: 145. 1884.

Radula spicata Aust. Bull. Torr. Bot. Club, **6**: 19. 1875. Pearson, List Can. Hep. 4. *pl. 4.* 1890. Not *Radula spicata* Mitt. Bonplandia, **10**: 19. 1862.

Light-green, slender, creeping, becoming intricately caespitose: stems 1–2 cm. long, pinnately or somewhat bipinnately branched, the branches mostly short: leaves contiguous or laxly imbricate, patent or erecto-patent, subascending, the obtuse carina arcuate and decurrent; dorsal lobes obovate, .35–.85 mm. long, .27–.65 mm. wide, nearly plane or slightly concave, almost longitudinally adnate to the stem, which the inner margin does not surpass, apex very obtusely rounded; ventral lobes of the leaves on the younger ramuli subequal to the dorsal lobes or one half as large, those of the adult leaves one third the size of the dorsal, inflated, rhomboidal-ovate, the obtuse or subacute apex more or less appressed to the dorsal lobe, the inner margin almost wholly adnate to the stem and scarcely incumbent, the outer margin obliquely truncate; leaf-cells 9–16 μ, the walls scarcely thickened at the angles: dioicous: androecia terminal on main stem or principal branches, numerous, linear, 3–7 mm. long, .5–.6 mm. wide, usually directed downward; ♂ bracts 10–35 pairs, very closely imbricated, strongly ventricose, the lobes equal: ♀ bracts of about the same size as the leaves, the lobes subequal: perianth obconic, 1.2–2 mm. long, .75–1.2 in greatest width, bilabiate, the lips entire: capsule prolate-ellipsoidal, exserted 1–2 mm., the valves about 1 mm. long, transverse striae of the inner cells very obscure or wanting; spores subglobose or ellipsoidal, 48–60 μ in maximum diameter, minutely and densely echinulate-papillate; elaters 150–200 μ × 6–8 μ.

On the trunks of trees (*Alnus*, *Umbellularia*, etc.). Common in the Coast Range Mountaius—at least, from San Francisco northward; Mill Valley, Marin Co.; Cazadero, Sonoma Co.; Mendocino (549); Eureka (918) and near McBride's, Mad River (1051), Humboldt Co. Vancouver Island (Macoun).*

2. RADULA COMPLANATA (L.) Dumort. Comm. Bot. 112. 1822.

Jungermannia complanata L. Sp. Pl. 1133. 1753.

Mostly yellowish-green, rather flaccid, closely and radially creeping, finally forming depressed mats: stems 1–6 cm. long, irregularly pinnate: leaves closely imbricate, patent, the margins occasionally gemmiferous; dorsal lobes quadrate-orbicular, .5–

* There seems to be little or nothing in the description and figure of Herr Stephani's apparently wholly sterile *Radula arctica* (from Chlowak and Chilcoot, Alaska.—Bot. Jahrb. **8**: 98. *pl. 3. f. 11.* 1886) to distinguish it from the juvenile condition of *Radula Bolanderi.*

1.6 mm. long by .4–1.5 mm. wide,* concave ventrally with the obtuse apex more or less deflexed, or nearly plane, the inner margin surpassing the stem; carina slightly arcuate; ventral lobe about one fourth the size of the dorsal, subquadrate, now and then a little elongated in a direction parallel to the carina, appressed to the dorsal lobe throughout or lightly inflated toward the base, subobtuse or acute, the inner superior angle free and somewhat incumbent upon the stem; leaf-cells 16–24 μ, the walls distinctly thickened at the angles: paroicous: perigonial leaves 2–4 pairs, immediately subtending the ♀ bracts, ventricose at base, the ventral lobes obtuse, ⅓–½ the size of the dorsal: ventral lobes of the ♀ bracts subequal to the dorsal or one half as large, obtuse: perianth obconic or elongate-obconic, 1.8–3 mm. long by .7–1.2 mm. in maximum width, strongly compressed, bilabiate, the lips entire or slightly repand: capsule prolate-ellipsoidal or obovoid, .9–1.3 mm. × .45–.55 mm., exserted about 1 mm.; spores subglobose, 30–38 μ, finely granulate-papillate; elaters 160–210 μ × 6–9 μ.

On branches and trunks of trees in moist or deeply shaded places (the species inhabits rocks also, but has not yet been found in such situations in California); Berkeley, Fruit Vale (Miss Byxbee); near Olema, Marin Co.; near Mendocino (707); Eureka (917) and Blue Lake (1015), Humboldt Co.; collected in California by Dr. Kellogg and probably also by Dr. Bolander, though we have seen no specimens of the latter's collecting.

It seems to us to be doubtful whether *Radula Krausei* Steph. (Bot. Jahrb. **8**: 97. *pl. 3. f. 10.* 1886)—at least as represented in Hep. Am. 149, a portion of which, we understand, was submitted to Herr Stephani before its distribution—can be satisfactorily distinguished from *R. complanata.* If we are not mistaken, the supposed distinctive characters of *Radula Krausei* pass quite imperceptibly into those of the Pacific coast *R. complanata,* which, we believe, cannot be well separated from the European plant.

34. PORELLA L. Sp. Pl. 1106. 1753. Ex Dill. Hist. Musc. 459. *pl. 68.* 1741. Lindb. Act. Soc. Sci. Fenn. **9**: 335. 1869.

Bellincinia Raddi, Atti Soc. Ital. Sci. Mod. **18**:—(7): 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 18. 1820.

* The dorsal leaf-lobes of *Radula complanata* are said by Herr Jack (Flora, **64**: 356. 1881) to be always broader than long, but we do not find them always so even in a specimen collected near Salem by Jack and Leiner. In the Californian specimens here referred to *R. complanata*—as well as in the North American plant in general—the leaves are ordinarily a little longer than broad.

Antoiria Raddi, Atti Soc. Ital. Sci. Mod. **18**:—(8): 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 19. 1820.

Cavendishia S. F. Gray, Nat. Arr. Brit. Pl. **1**: 689. 1821.

Madotheca Dumort. Comm. Bot. 111. 1822. Nees, Naturgesch. Eur. Leberm. **3**: 157. 1838.

Plants large, dark-green to yellowish-brown, mostly somewhat regularly bi- or tri-pinnate, rarely subsimple; root-hairs in tufts at the base of the underleaves, usually sparingly developed. Leaves very deeply 2-parted; the dorsal lobes large, incubous, obliquely orbicular-ovate to oblong, entire, repand or somewhat dentate; ventral lobes much smaller than the dorsal, sometimes nearly discrete, ovate, lingulate, oblong, linear, or lanceolate, nearly parallel with the stem, entire or toothed, margins plane or revolute. Underleaves large, somewhat similar in form to the ventral lobes but usually broader, entire or dentate, often long decurrent on both sides. Antheridia spherical, very short-stalked, single in the axils of saccate, densely imbricate, nearly equally bilobed opposite leaves, these connate with the underleaves and forming short, lateral, oval, to linear-oblong spikes. Archegonia generally numerous, terminal on very short (most rarely a little elongated) lateral branches. Perianth oval to obovate, flattened dorso-ventrally toward the mouth, from a more or less obconical base, much longer than the bracts, two-lipped after elevation of the capsule or sometimes irregularly torn, mouth ciliate, dentate, or subentire. ♀ bracts usually a single pair with a single bracteole in addition to the underleaf at the base of the branch, the latter underleaf united with the subtending cauline leaf and functioning as its ventral lobe, or free, leaving the cauline leaf unlobed. Capsule spherical to ovoid-oblong, on a short seta, yellowish-brown, opening, usually not quite to the base, by four often irregularly split valves; cell-walls of the valves mostly with irregular nodulose thickenings. Elaters commonly 2-(1–3-) spiral; spores several times broader, more or less echinulate.

Key to the Species.

Stems subsimple or somewhat fasciculately branching, short, tumid; underleaves caudate-lacinulate at base; perianth-mouth ciliate. 1. *P. Bolanderi.*

Stems more or less regularly 1–3-pinnate.

Usually shining.

Ventral lobes more or less spurred outwardly at base, mostly linguiform or ovate-oblong, margins plane or lightly recurved. 3. *P. Roellii.*

Ventral lobes regularly rounded outwardly at base, ovate, margin recurved. 4. *P. navicularis.*

Usually dull; rather flaccid, dorsal lobes subimbricate, ventral lobes long-decurrent, underleaves distant. 2. *P. rivularis.*

1. PORELLA BOLANDERI (Aust.) Pearson, List. Can. Hep. 7. 1890.

[Excluding specimens cited (?)]

Madotheca Bolanderi Aust. Bull. Torr. Bot. Club, 3 : 14. 1872.

Dark- or yellowish-green, dull : stems 1.5–6 cm. long, subsimple or with a few somewhat fasciculately disposed obtuse tumid branches, often subpendulous, more or less vaulted or flexuous when dry : dorsal lobes of leaves densely imbricate, appressed or subsquarrose, dimidiate-ovate to oblong, 1.5–2.9 mm. × .67–1.8 mm., sometimes considerably narrowed toward the obtuse apex, slightly decurved when moist, circumvolute-deflexed in drying, rather distinctly margined by somewhat inflated subrectangular cells, the inferior margin more or less undulate, often narrowly inflexed, the superior repand or here and there caudate-dentate, the base long drawn out and projecting beyond the stem, trigones small ; ventral lobes and underleaves approximate or more often imbricate, sometimes entirely concealing the stem ; ventral lobes ovate-lanceolate to linear-lanceolate, rarely almost subulate, acute or occasionally somewhat obtuse, subfalcate, canaliculate, slightly twisted, long-decurrent, nearly discrete, .4–1 mm. × .08–.4 mm., about ½ as wide as the underleaves, length $\frac{2}{5}$–$\frac{3}{5}$ the width of the dorsal, undulate-repand above, sparingly caudate-lacinulate on inner side at base, often also on the outer : underleaves ovate-lingulate to oblong, a little wider than the stem, apex obtuse, subacute, rarely emarginate or slightly cleft, often deflexed, margins plane or recurved, undulate-repand, long-decurrent, the wings with commonly 2 or 3 cauda-like laciniae on either side toward the base : dioicous : ♂ spikes oblong to almost linear, 2–4 mm. in length : ♀ branch short ; dorsal lobes of ♀ bracts subobtuse or acute, the ventral acute or often subulate-pointed, margins of both subentire or denticulate above, ciliate-caudate at base, bracteole large, ovate, usually acute, denticulate above, caudate-lacinulate below ; underleaf subtending ♀ branch acutely emarginate or bifid ; perianth broadly ovate from a shortly obconic base, somewhat compressed, lightly undulate-plicate dorsally, often furnished ventrally with 2 or three rarely winged carinae, narrowed at the ciliate, subtruncate, deeply bilabiate mouth : capsule oval or oval-oblong, exserted by about its own length ; spores 29–40 μ, minutely echinulate ; elaters 180–310 μ × 10–12 μ, 2- (3-) spiral.

EXSICC. Hep. Am. 31.

On stones, under shelving rocks, and on the bark of living trees, especially of *Quercus agrifolia*.

First collected by Dr. Bolander. Berkeley (7, 1189, 1190, 1197), Fruit Vale (1219), San Leandro (Underwood) ; Mitchell

Cañon, Mt. Diablo (1195, 1196, 1218); Ukiah (756), Pieta (797), Mendocino Co.; near Hay Fork (1108), Trinity Co.; Oak Run and Cow Creek, Shasta Co. (M. S. Baker and F. P. Nutting); Nordhoff, Ventura Co. (Miss Jacqueline K. Newton); Pasadena and Elsinore (A. J. McClatchie).

Type in herb. Pearson, Knutsford, Cheshire, England. We have seen no specimens of *Porella Bolanderi* from any station outside of California. Can. Hep. no. 10 (distributed as *P. Bolanderi*) is, so far as we have seen it, *Porella rivularis*—in one pocket mixed with *P. navicularis*. Can. Hep. no. 11 (issued as *Porella Bolanderi* var.), from Mt. Benson, Vancouver Island, is *Porella Roellii* Stephani.

In moist, densely shaded places, *Porella Bolanderi* assumes a more lax, flaccid habit, resembling certain forms of *P. rivularis*. Such conditions, however, when the characteristic ciliate perianths are wanting, can usually be distinguished from any state of *P. rivularis* by the more oblong, more distinctly marginate, dorsal leaf-lobes, and by the longer and narrower ventral lobes and underleaves, which are more pronouncedly caudate at the base.

PLATES 111 and 112. PORELLA BOLANDERI.

1–3. Plants, ♀, natural size.
4. Plant, ♂, natural size.
5. Portion of plant, ventral view, × 12.
6. Mature perianth and part of stem, ventral view, × 12.
7. Young perianth, bracteole, bracts, etc., ventral view, × 12.
8. Half of mouth of young perianth, × 53.
9 and 10. Transverse sections of perianth, the lower side ventral, × 23.
11–13. Cauline leaves, showing the ventral lobe, × 23.
14. Leaf and ventral lobe, × 12.
15–17. Leaves, dorsal view, × 12.
18 and 19. Underleaves, × 23.
20. Leaf-cells, × 305.

Figs. 1 and 2 from specimen collected in Fruit Vale by Miss Byxbee; 3, 5, 14, 16, 17, and 20, from no. 1190 (Berkeley); 4, from no. 1189 (Berkeley); 6 and 12, from no. 1196 (Mt. Diablo); 7–10, 13, 15, and 19, from no. 7 (Berkeley); 11 and 18, from no. 1195 (Mt. Diablo).

2. PORELLA RIVULARIS (Nees) Trevis. Mem. r. Ist. Lomb. III. **4**: 407. 1877.

Madotheca rivularis Nees, Naturgesch. Eur. Leberm. **3**: 196. 1838.

Porella dentata Lindb. Act. Soc. Sci. Fenn. 9 : 342. 1869.

Dull, or very rarely a little polished, opaque, commonly dark green, sometimes yellowish, mostly soft and flaccid : stems irregularly pinnate or subdichotomous, 3–10 cm. long, prostrate or ascending, forming loose or more dense mats, branches somewhat obtuse, scarcely diminishing in width toward apex : dorsal lobes of leaves usually subimbricate or approximate, sometimes distant, rarely closely incubous, obliquely ovate to orbicular-ovate, rounded-obtuse, 1–2 mm. × .8–2 mm., entire or subdenticulate, flat or slightly concave beneath, only a little decurved at the apex, trigones mostly small ; ventral lobes small, obliquely ovate, acute, .35–.7 mm. × .12–.4 mm., length $\frac{1}{3}$–$\frac{2}{5}$ the width of the dorsal, about one half as broad as the underleaves, margins, especially the outer, for the most part broadly revolute, often giving the lobe a twisted appearance, long decurrent, usually dentate or subciliate at base internally and sometimes unindentate externally but scarcely spurred : underleaves distant, quadrate, orbicular to broadly ovate, about twice the width of the stem, apex rounded-obtuse, sometimes reflexed, margins repand-undulate, very long decurrent, the wing sometimes exceeding the free portion in length and usually acutely dentate or subciliate : dioicous : ♂ spikes oval to oblong, 1.5–2.5 mm. in length : ♀ branch short : ventral lobes of the single pair of ♀ bracts acute or subobtuse, entire or repand, the dorsal obtuse, bracteole ovate-linguiform, repand ; perianth ovate, with lateral margins deflexed, deeply bilabiate, the lips subentire or repand-dentate, usually plane : spores 27–45 μ, papillate-echinulate ; elaters 180–290 μ × 8–10 μ, rather obtuse, 2(3-) spiral.

Exsicc. Hep. Am. 150 (as *Porella Roellii*, var.), 194A, and 194B.

On moist rocks, stones in streams, and bases of trees in densely shaded places. Widely distributed and extremely variable according to habitat.

Near Berkeley (7d, 7e, 19, 1175, 1182, 1214) ; Mill Valley and Olema (1178) ; Cazadero (1179) ; Mendocino (714, 718) ; Ukiah (745) ; Blue Lake (1177) ; Russ & Graham's Ranch (1084) Humboldt Co.; Sisson, Siskiyou Co., (1176) ; Cow Creek and Burney Falls, Shasta Co. (M. S. Baker & F. P. Nutting) ; Yosemite Valley region (C. M. Cooke, Jr.). Collected in California by Dr. Bolander also, the exact localities unknown, and by Mr. S. B. Parish in the southern part of the state.

Our determination is based upon the drawing (accompanying G. & R. Hep. Eur. no. 371) of the original plant from the bed of

the river Bober, near Hirschberg, Silesia, and upon European specimens and the descriptions of authors.

The name *dentata*, applied by Hartman in 1832 (Skand. Fl. 354, 2d ed.) to what he considered a variety of *Jungermannia platyphylla* was taken up for the above species by Lindberg in 1869, but was abandoned by him ten years later without explanations. Hartman's description of his variety *dentata* is quite inadequate for its proper identification and as we have failed in our efforts to see his original specimens, if such exist, we prefer to adhere to the first name which was accompanied by an intelligible diagnosis.

3. PORELLA ROELLII Steph. Bot. Centralb. **45**: 203. 1891.

Green or yellowish-brown, usually shining: stems procumbent, rather flaccid, densely depressed-caespitose, 4–8 cm. long, subdichotomous below, the primary branches for the most part simply and remotely pinnate, branchlets short, often attenuate-deflexed: dorsal lobes of leaves densely imbricate, appressed, obliquely ovate, patent-divergent, .85–1.7 mm. × .65–1.5 mm., apex narrowed, subtruncate, obtuse, or most rarely apiculate, inferior margin more or less undulate-crisped, the superior repand, cells at basal angles slightly smaller, all with evident trigones; ventral lobes ovate, linguiform or ovate-oblong, usually much narrowed toward the obtuse or subacute apex, suberect or patent, scarcely connate with the dorsal, commonly about ½ as wide as the underleaves, length ⅔ the width of the dorsal, somewhat concave ventrally, margins plane or slightly recurved, a little decurrent, very rarely dentate above, more or less strongly spurred at the base, especially at the outer angle, the spur entire or dentate, rarely subciliate: underleaves approximate, ovate-linguiform, rounded-obtuse, the margins recurved, long-decurrent, entire or most rarely subdentate, the wings sometimes crisped: dioicous: ♂ spikes 1–2 mm. long: ♀ branch somewhat elongated, bearing 3–8 leaves (or "bracts") (usually 2 pairs) nearly similar to the cauline; inmost bracts a little larger, the lobes subacute, entire, repand-dentate, or sparingly denticulate, bracteole ovate, subentire or denticulate; perianth large, somewhat goblet-shaped or broadly obovate, undulate-concave ventrally, here and there inflated, scarcely narrowed or lobed at the wide truncate dentate mouth, the oral margins plane or slightly deflexed at the sides.

Under shelving rocks and on moist shaded cliffs, rarely on tree-trunks. Mill Valley (1168) and Mt. Tamalpais (1171), Marin

Co.; near Cazadero (1170), Sonoma Co.; Ukiah (759) and Navarro (Miss Edith S. Byxbee), Mendocino Co.; Blue Lake (994) and Deer Creek (1068, 1073, 1231), Humboldt Co.; Hay Fork (1109), Trinity Co.

Type from Kitchelos Lake, Washington (Roell, June 12, 1888) —in herb. Stephani, Leipsic. Type duplicate in herb. Underwood.

Porella Roellii is closely related to the forms of the European *P. laevigata* with obtuse dorsal lobes and subentire ventral lobes and underleaves, as represented, for example, in Carrington and Pearson's no. 275 Hep. Brit. Exsicc., from Scotland. This is especially true of British Columbia specimens (Macoun: Cascades, Yale, May, 1875; no. 63, near Victoria, May 30, 1893), and of our no. 1068. These latter differ, however, from *P. laevigata* in the smaller, narrower, more pointed, and more strongly calcarate ventral lobes, and in the usually more slender fronds. They are forms like these, we take it, that have been referred by Mr. Pearson * to *P. laevigata*, but in the predominating forms in Washington, Oregon, and California the plant is much less suggestive of *P. laevigata*, and we prefer to maintain Stephani's species, and to associate with it the British Columbia specimens alluded to and our no. 1068, even though, as must be admitted, they make a near approach to certain conditions of the European plant. Perianths occur only in our nos. 994 and 1231; they appear to differ but slightly from those borne by a specimen of *P. laevigata* from Teneriffe, which we owe to the kindness of Matthew B. Slater, Esq., of Malton, England.

PLATES 113 AND 114. PORELLA ROELLII.

1. ♀ plant, natural size.
2 and 3. Sterile plants, natural size.
4. ♂ plant, natural size.
5. Portion of plant, ventral view, × 12.
6–8. Cauline leaves, showing ventral lobes, × 23.
9. Rameal leaf, ventral view, × 23.
10 and 11. Underleaves, × 23.
12 and 13. ♀ branches, with bracts and mature perianths, × 12.
14. Outline of cauline leaves, dorsal view, × 12.
15. Leaf-cells, × 305.
16 and 17. Leaves, viewed dorsally, × 12.

* List of Canadian Hepaticae, 7. 1890.

18. About one fourth of perianth-mouth, × 53.

Figs. 1, 12, 13, and 18, drawn from no. 994 (Blue Lake, Humboldt Co.); 2, from no. 759 (Ukiah); 3, from no. 1109 (Hay Fork, Trinity Co.); 4, from no. 1168 (Mill Valley); 5, 6, 8–10 and 14–17, from a portion of the original material collected by Roell at Kitchelos Lake, Washington, and communicated to Professor Underwood by Herr Stephani; 7 and 11, from no. 1068 (Deer Creek, Humboldt Co.).

4. PORELLA NAVICULARIS (Lehm. & Lindenb.) Lindb. Act. Soc. Sci. Fenn. **9**: 337. 1869.

Jungermannia navicularis Lehm. & Lindenb.; Lehm. Pugill. **6**: 38. 1834.

Madotheca navicularis Nees, *p. p.* G. L. N. Syn. Hep. 277. 1845.

Madotheca Douglasii Tayl. Lond. Jour. Bot. **5**: 379. 1846.

Madotheca Californica Hampe, in herb. Sullivant, *fide* Austin, Hep. Bor.-Am. 91.

Shining or more rarely dull, brownish-yellow, large: stems somewhat regularly bipinnate, 4–12 cm. long, procumbent-caespitose, or subpendulous with apices ascending when moist, branchlets gradually narrowed, subacute, convex on drying and slightly deflexed: dorsal lobes of leaves densely imbricate, appressed, for the most part closely wrapped about the stem when dry, obliquely orbicular-ovate to oblong-ovate, 1.2–2.5 mm. × 1–1.8 mm., rounded-obtuse, apex decurved, subcucullate, inferior margin slightly undulate-crisped, the superior decurrent, its wing sometimes laciniate-crispate, otherwise very entire, the inferior basal angle composed of numerous small thick-walled cells ¼–½ the diameter of the remainder, trigones conspicuous throughout; ventral lobes ovate, obtuse, most rarely subacute, regularly rounded outwardly at base, .5–1 mm. × .33–.75 mm., a little smaller than the underleaves, length somewhat more than ½ the width of the dorsal, margins entire, recurved, decurrent, apex often deflexed: underleaves approximate, quadrate-oblong, rounded-obtuse, margins entire, recurved, long-decurrent, apex occasionally deflexed: dioicous: ♂ branches oval to oblong, 1½–2½ mm. in length: ♀ branch short, lobes of the single pair of bracts minutely denticulate or entire, the ventral usually acute, the dorsal obtuse, bracteole wide; perianth broadly obovate from an obconic somewhat inflated base, scarcely narrowed above, deeply bilabiate, the lips at first subciliate-denticulate, later obsoletely crenulate-dentate or nearly entire, strongly revolute, giving perianth the appearance of being squarely or obliquely truncate: capsule ovoid, yellowish-brown, exserted by about its own length; spores 50–85 μ, echinu-

late, bright yellowish-green; elaters 275–325 μ × 9–10 μ, obtuse, 2-(3-) spiral.

Exsicc. Hep. Bor.-Am. 91.

Hep. Am. 30.

Common on trunks and branches of trees and more rarely on rocks throughout the Pacific Coast from California to Alaska; as far east as Idaho (Leiberg); Mexico (*fide* Gottsche).

Mill Valley (1215), Olema (1216, 1217); Duncan's Mills (1180), Cazadero (1181), Sonoma Co.; Mendocino (563, 564), Navarro (Miss Edith S. Byxbee), Ukiah (776); Mission Hills, San Francisco (Dr. Kellogg); Lake Pilarcitos, San Mateo Co. (W. C. Blasdale); Santa Cruz Mts. (Underwood). Collected in California also by the botanists of Beechey's expedition (in herb. Taylor), by Dr. Bolander and others.

The original specimens were collected by Menzies on the western coast of North America, exact locality unknown. Lindenberg's specimen of "*Jungermannia navicularis* n. sp." is preserved in the Naturhistorisches Museum at Vienna. We are indebted to Prof. Dr. G. von Beck for the privilege of seeing a portion of this type. The European plants referred by some authors to *Porella navicularis* probably all belong with *P. platyphylla* or *P. laevigata.* This species in a fertile condition can always be very easily distinguished from any simulating form of *P. platyphylla* by the broadly obovate perianth, scarcely narrowed at the mouth, and by the twice larger diameter of the spores. When sterile, if more obvious characters fail, the numerous, small, thick-walled cells filling the inferior basal wing of the dorsal lobe are of importance; these are ¼–½ the diameter of the cells in the middle of the lobe while in *P. platyphylla* the cells are nearly of a uniform size throughout the lobe or slightly smaller at the basal margin.

In two cases, we have observed a peculiar modification of *Porella navicularis* due, we believe, to the influence of an epiphytic fungus. The leaves were here *bilobed* rather than *bipartite*, the union of the lobes resembling that of *Lejeunia* or *Radula.* The ventral lobes were shortened so that their longer axis was nearly parallel to that of the dorsal lobe and were conspicuously inflated as in most of the *Lejeuniae.* The underleaves were also shortened and often ventricose. In fact, when, as sometimes happened, a

sterile plant was thus transformed throughout, there was little, outside of the axillary branching, to distinguish it from the holostipous *Lejeuniae*. The inflated cavities of the ventral lobes and sometimes also those of the underleaves were mostly occupied by one or more yellowish or colorless subspherical bodies, 40–120 μ in diameter, probably sporangia of a fungus belonging to the order *Chytridiales*, perhaps to the genus *Rhizophidium* Schenk. At maturity, the contents of some of the globose bodies become resolved into numerous minute ovoid colorless masses, 4–6 μ in diameter. In both of the cases where the *Porella* was thus affected it was growing in company with species of *Radula* (*Radula complanata*, near Mendocino, no. 707, and *Radula Bolanderi*, near McBride's, Mad River, Humboldt Co., no. 1051).

PLATES 115 AND 116. PORELLA NAVICULARIS.

1 and 2. Plants, ♂ and ♀, natural size.
3. Portion of ♀ plant, viewed ventrally, × 12.
4–7. Leaves, showing ventral lobes, × 12.
8 and 9. Underleaves, × 23.
10. Outline of cauline leaves, dorsal view, × 12.
11. ♀ branch, with young perianth, bracts, bracteole, etc., ventral view, × 21.
12. Mature perianth, ventral aspect, and sporogonium, × 12.
13. Inferior basal margin of dorsal lobe, × 25.
14 and 15. Leaves, dorsal aspect, × 12.
16. One half of mouth of young perianth, × 53.
17. Leaf-cells, × 305.

Figs. 1, 7, and 15 drawn from no. 776 (Ukiah); 2, 3, 6, 8, 11, 12, 14, and 16, from no. 564 (Mendocino); 4, 5, 9, and 10, from no. 1215 (Mill Valley).

35. FRULLANIA Raddi, Atti Soc. Ital. Sci. Mod. **18**:—(9). 1818. Mem. Mat. e Fis. Soc. Ital. Sci. Mod. **18**: 20. 1820. Spruce, Trans. and Proc. Bot. Soc. Edinb. **15**: 3. 1884.

Plants large or small, depressed-caespitose, mostly reddish-brown, less commonly green or nearly black. Stems moderately stout, opaque, composed of several layers of small cells, pinnately ramose, the branches all lateral, each arising exactly in the axil of a cauline leaf, from which it is always free; root-hairs springing in tufts from the bases of the underleaves. Leaves alternate, somewhat obliquely or almost transversely inserted, complicate-bilobed; the dorsal lobes incubous, obliquely ovate to suborbicular, nearly always entire; ventral lobes (lobules) usually developed as inflated galeate, cucullate, cylindrical-clavate, or rarely digitiform water-sacs, or sometimes evolute, more or less distant from the stem,

commonly bearing near the base on the side toward the stem a small or minute, subulate or triangular process (stylus); lobule of the leaf subtending a branch mostly explanate and almost equally bifid; leaf-cells mostly small to medium-sized, with more or less conspicuous trigones at the angles and sometimes also with intermediate lateral thickenings. Underleaves always present, considerably smaller than the leaves, bifid (very rarely entire). Dioicous or autoicous (rarely paroicous). Androecia usually occupying short lateral branches, globose to oblong; ♂ bracts saccate, closely imbricate, about equally 2-lobed; antheridia 2–4. Archegonia usually 2–4, very rarely as many as 12, acrogenous or cladogenous, "subfloral" innovations always wanting. ♀ bracts 2–5 pairs, larger than the leaves, free from the perianth, the two of the inmost pair (in extra-limital species) occasionally connate with the bracteole and with each other to form a gamophyllous exciple; lobules evolute, subentire or more or less dentate, ciliate, or laciniate; bracteole often connate with one or both of the inmost bracts. Perianth free, commonly emersed, more or less compressed dorsoventrally, trigonous in cross-section with the third angle ventral or sometimes tetragonous with two ventral angles, often bearing in addition several shorter supplementary dorsal or ventral folds or ridges, otherwise smooth or in a few species roughened by tubercles, contracted at the apex to a tubular rostellum, irregularly ruptured by the exsertion of the capsule. Calptra free, included, pyriform or obovoid, fleshy. Capsule globose, exserted on a short seta, dehiscing by four valves for about ⅔ the distance from the apex to the base, the valves composed of two layers of cells, those of the outer layer rather large and thick, with strong columnar thickenings (appearing nodular in surface view) at the angles and in the lateral walls, those of the inner layer smaller and thinner, more or less papilliform, their boundaries obscured by irregular thickenings; the basal uncleft portion of the capsule-wall made up of several layers of thin-walled colorless cells. Seta scarcely exceeding the perianth or 2–3 times longer, stout, 8 or 9 cells in diameter, with cells alternate (*i. e.*, seta not appearing articulate in surface view), abruptly dilated above to form the base of the capsule. Elaters rather few, stout, unispiral, persistently affixed to the upper half of the capsule-valves, the free ends truncate or with a trumpet-like expansion. Spores large, papillate or verruculose.*

* The North American species of *Frullania* have been admirably figured and described by Dr. Alexander W. Evans (Trans. Conn. Acad. **10**: 1–39. *pl.* 1–15. May, 1897). The following descriptions of the Californian species are taken with but slight modifications from Dr. Evans' paper.

Key to the Species.

Lobules galeate (when inflated), about as broad as long; perianth terminal on the main stem or a leading branch.

Dioicous, flagelliferous; lobules (excepting those of bracts and of leaves subtending branches) always inflated, slightly longer than broad. 1. *F. Bolanderi.*

Autoicous, flagella wanting; lobules, when inflated, broader than long, very often evolute. 2. *F. Catalinae.*

Lobules oval-cylindrical to short-clavate, 1¼–2½ times as long as broad; dioicous; perianth terminal on a rather short lateral branch.*

Dorsal lobes of the leaves rounded-obtuse to acuminate-apiculate, usually (but not always) marked with a short median line of slightly enlarged discolored cells; lobules separated from the stem by about their own width; underleaves mostly rhombic-obovate, gradually narrowed to the base and without a trace of an auricle, the margins plane, often bluntly unidentate on either side. 4. *F. Franciscana.*

Dorsal lobes of the leaves rounded-obtuse, discolored cells scattered or wanting; lobules separated from the stem by less than half their width; underleaves subquadrate-orbicular, more or less auriculate at base, the margins plane or slightly recurved at the sides. 3. *F. Californica.*

Dorsal lobes of the leaves acute or more commonly acuminate-apiculate, discolored cells scattered or wanting, rarely in a short median line; lobules separated from the stem by about their own width; underleaves suborbicular or reniform, auriculate at base, the margins strongly recurved at least toward the apices. 5. *F. Nisquallensis.*

I. Subgenus TRACHYCOLEA Spruce.

1. FRULLANIA BOLANDERI Aust. Proc. Acad. Nat. Sci. Philad. 1869: 226. 1869. Evans, Trans. Conn. Acad. 10: 8. *pl.* 2. 1897.

Frullania Petalumensis Gottsche; Bolander, Cal. Med. Gaz. 1870: 184 (40) (name only). 1870.

Frullania Hallii Aust. Bull. Torr. Bot. Club, 6: 20. 1875.

Dark green, varying to reddish-brown, closely appressed, diffusely repent or caespitose: stems 6–20 mm. long, .07–.14 mm. in diameter, irregularly pinnate, the branches often prolonged into erect or ascending flagella, these crowned at the apex with a few small well-developed leaves but furnished otherwise only with patent-horizontal or subsquarrose underleaves and the merest rudiments of lateral leaves: dorsal lobes of leaves mostly subimbricate, ascending when moist, obliquely ovate or semiorbicular, .35–.5 mm. × .27–.45 mm., arching over the stem and subtruncate at base, entire, the slightly decurved apex rounded-obtuse; lobules large, galeate, .23–.32 mm. × .2–.27 mm., truncate at base, close to the

* While the three Californian species of this section are closely allied and have long been confused, they are nevertheless entirely distinct. The credit of finally disentangling and defining them belongs largely to Dr. Evans.

stem; stylus small, lanceolate or subulate: underleaves distant, rhombic-obovate or somewhat orbicular, slightly exceeding the stem in width, bifid about one third their length with mostly subacute lobes and sinus, margins plane, entire or bearing one or two teeth at the sides: superior and median cells of the dorsal lobes 18–30 μ, all rather thick-walled, trigones small or conspicuous, intermediate thickenings very rarely developed: dioicous: androecia ovoid to oblong, ♂ bracts in 4–15 pairs: archegonia 3 or 4, terminal on the main stem or a leading branch: ♀ bracts in two or three pairs, gradually two or three times larger than the leaves, unequally bifid, the dorsal lobes ovate, rounded-obtuse, entire or slightly repand; lobules ovate or lanceolate, obtuse or subacute, plane or lightly concave ventrally, entire except for a small tooth (stylus) near the middle of the inner margin: bracteole connate on one or both sides, ovate or oblong-ovate, commonly bifid ¼–⅓ its length with acute lobes and sinus but sometimes rounded at apex or merely emarginate, rarely 3- or 4-dentate: perianth about half-emersed, obovoid, 1.2–1.6 mm. × .8–1.3 mm., with a rather broad, usually two-angled ventral keel and one or more supplementary ventral and dorsal ridges, very rarely with a few scattered tubercles, the beak short and broad and usually flaring at the mouth: capsule exserted by about its own diameter; spores variable in form and size, mostly 40–60 μ in greatest diameter.

Exsicc. Hep. Bor.-Am. 105b.
Hep. Am. 28.

On the bark of living trees (*Quercus*, *Alnus*, *Umbellularia*, *Aesculus*, etc.). Very common, especially in the Coast Range counties. Berkeley, Fruit Vale, and San Leandro (Prof. L. M. Underwood, June, 1888), Alameda Co.; Mission Dolores (Bolander), San Francisco; Tomales (Bolander) and Mill Valley, Marin Co.; Kenwood (Mr. F. T. Bioletti), Sonoma Co.; Mendocino (Bolander); Blue Lake (1004), Humboldt Co.; Mt. Diablo, Contra Costa Co.; Monterey (Prof. W. G. Farlow, May, 1885) and Pacific Grove, Monterey Co.; San Gabriel Mountains, near Pasadena (Prof. A. J. McClatchie, June 1893). The species extends northward to British Columbia.

2. FRULLANIA CATALINAE Evans, Trans. Conn. Acad. **10**: 11. *pl. 4.* 1897.

Reddish-brown, sometimes tinged with green, depressed-caespitose: stems 5–15 mm. long, .1–.18 mm. in diameter, irregularly pinnate: dorsal lobes of leaves imbricate, squarrose or semivertical

when moist, obliquely ovate, .45–.7 mm. × .4–.62 mm., arching over the stem and subtruncate at base, entire, the slightly decurved apex rounded-obtuse; lobules inflated and broadly galeate, .16–.18 mm. long, .2–.27 mm. wide, separated from the stem by about one fourth their width, or very often imperfectly inflated or wholly explanate, then ovate-linguiform, .18–.3 mm. long, .1–.18 mm. wide; stylus subulate, minute: underleaves distant or contiguous, plane, broadly rhombic or rhombic-obovate, mostly 1–2 times the width of the stem, bifid ⅓–½ their length, with obtuse or subacute lobes and sinus, entire or more commonly unidentate on the sides: superior and median cells of the dorsal lobes 16–30 μ, all with slightly thickened walls, small trigones, and no intermediate thickenings: autoicous: androecium small, ovoid, occupying a short branch springing from near the involucre, ♂ bracts 1–3 pairs: archegonia about 6, terminal on the stem or the principal branches; ♀ bracts in two or three pairs, gradually larger than the leaves, unequally bifid, the dorsal lobes ovate, entire or subcrenulate toward the base, obtuse; lobules shorter and narrower, ovate, obtuse or subacute, bearing a single distinct tooth or segment slightly above the middle of the inner edge, otherwise entire: bracteole oblong or narrowly ovate, connate on one side with bract, bifid for ⅓ or more of its length, with lanceolate parallel or somewhat divergent lobes, otherwise entire or sometimes unidentate toward the base of the free margin: perianth about half-exserted, broadly fusiform to obovoid-pyriform, 1.4–1.8 mm. × .75–1.1 mm., with a distinct two-angled ventral keel and one or more less pronounced dorsal and ventral ridges, gradually narrowed to a short broad beak: spores 30–40 μ in greatest diameter, thickly and minutely granulate-papillate.

On rocks in a cañon, Santa Catalina Island (Professor A. J. McClatchie, Sept. 8, 1893).

II. Subgenus THYOPSIELLA Spruce.

3. FRULLANIA CALIFORNICA (Aust.) Evans, Trans. Conn. Acad. **10**: 25. *pl. 12. f. 11–22.* 1897.

Frullania Grayana Californica Aust. *p. p.*; Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 67. 1884.

Frullania Asagrayana Californica Aust. (*ch. emend.*), M. A. Howe, Erythea, **2**: 98. 1894.

Frullania Asagrayana alsophila M. A. Howe, Erythea, **2**: 99. 1894.

"*Frullania Tamarisci* Nees, ?"; Bolander, *p. p.* Cal. Med. Gaz. 1870: 184 (40). 1870. Not *Frullania Tamarisci* (L.) Dumort.

Green, reddish-brown, or fuscous, densely depressed-caespitose or rather laxly repent: stems light brown or greenish, 1–3 cm. long, .1–.22 mm. in diameter, once or twice pinnate: dorsal lobes of leaves more or less imbricate, suborbicular, those of the main stem .45–.8 mm. × .35–.8 mm., all arching over the stem and cordate at base, entire, rounded-obtuse and somewhat decurved at apex, discolored cells scattered or wanting; lobules oval-cylindrical to short-clavate, .13–.22 mm. × .09–.13 mm., separated from the stem by less than half their width; stylus minute, subulate or disc-like: underleaves distant or approximate, subquadrate-orbicular, 1–3 times the width of the stem, more or less auriculate at base, bifid about ⅓ their length with mostly subacute lobes and narrow or broad sinus, margins entire, plane or slightly reflexed at the sides: superior and median cells of the dorsal lobes mostly 10–20 μ, all rather thick-walled, trigones inconspicuous and intermediate thickenings scanty: dioicous: androecia subglobose, ♂ bracts 2–5 pairs: archegonia terminal on a short branch: ♀ bracts in two or three pairs, unequally bifid, the dorsal lobes ovate or ovate-lanceolate, acute, entire; lobules lanceolate or subulate, acuminate, often canaliculate or tubulose by the recurving of the margins, sometimes falcate, bearing on the inner margin a laciniate lobe-like segment, otherwise entire: bracteole connate with the bract on one side, ovate, bifid to about the middle with subulate-acuminate or lanceolate-acuminate lobes and bearing on either side at the base a distinct usually laciniate segment, otherwise entire: perianth ovoid, 1.6–2 mm. × .9–1.2 mm., somewhat gradually or rather abruptly narrowed to the short beak, strongly unicarinate ventrally, smooth: mature sporogonium unknown.

Exsicc. Hep. Bor.-Am. 108, *p. p.* (distributed as *F. Nisqualensis*).

Hep. Am. 197.

On rocks, logs, and trunks of living trees. Mission Dolores (Bolander) and Clarendon Heights (Howe), San Francisco; Mill Valley and Olema, Marin Co.; Duncan's Mills (1209) and "Turner's Cañon," Sonoma Co.; "Wildcat Cañon," near Berkeley; near Lake Pilarcitos, San Mateo Co. (Blasdale); Pacific Grove, Monterey Co. There are in existence several additional specimens of Dr. Bolander's collecting, attributed simply to "California." The species extends as far north as Victoria, B. C., where it has been collected by Professor Macoun.

4. FRULLANIA FRANCISCANA M. A. Howe, Erythea, **2**: 99. *pl. 2.* 1894. Evans, Trans. Conn. Acad. **10**: 26. *pl. 13. f. 1–8.* 1897.

Frullania Grayana Californica Aust. *p. p.*; Underw. Bull. Ill. State Lab. Nat. Hist. **2**: 67. 1884.

Frullania unciflora Californica Gottsche; Bolander, Cal. Med. Gaz. 1870: 184 (40) (name only). 1870.

"*Frullania Tamarisci* Nees?"; Bolander, *p. p.* Cal. Med. Gaz. 1890: 184 (40). 1870. Not *Frullania Tamarisci* (L.) Dumort.

Reddish-brown, varying to greenish, forming wide depressed mats: stems 1.5–4 cm. long, .1–.2 mm. in diameter, light brown or greenish, mostly bipinnate; dorsal lobes of leaves imbricate, obliquely ovate, those of the main stem and principal branches .6–1 mm. × .45–.8 mm. all arching over the stem and cordate at base, usually marked with a short median line of discolored slightly enlarged cells, entire, the decurrent apex from rounded-obtuse to acuminate-apiculate; lobules oval-cylindrical to short-clavate, .18–.23 mm. × .1–.14 mm., separated from the stem by about their own width; stylus minute: underleaves distant, subquadrate-rhombic to obovate, mostly rhombic-obovate, usually 2–2½ times the width of the the stem, gradually narrowed to the neither auriculate nor appendiculate base, bifid about ⅓ their length with narrow sinus and obtuse lobes, the margins plane, usually bluntly unidentate near the middle: superior and median cells of the dorsal lobes mostly 16–25 μ, all rather thick-walled, trigones and intermediate thickenings becoming more conspicuous toward the middle and the base: dioicous: androecia subglobose or oval, ♂ bracts 3–7 pairs; antheridia in 3's: archegonia terminal on a short branch: ♀ bracts in commonly three pairs, unequally bifid, the dorsal lobes of the inmost pair ovate, acute or acuminate-apiculate or rarely obtuse, ciliate at the dorsal base, otherwise entire; lobules ovate or lanceolate, acute, slightly concave ventrally, ciliate at the ventral basal margin, otherwise entire: bracteoles connate with the bract on one side, ovate, bifid to about the middle with a narrow sinus and lanceolate acuminate lobes, ciliate at base, otherwise entire: perianth oblong-obovate, 1.5–2.3 mm. × .9–1.1 mm., abruptly short-rostrate, strongly unicarinate ventrally, smooth: capsule exserted by about twice its own diameter of .7–.8 mm., spores 60–80 μ in greatest diameter, the verruculae mostly aggregated in small circular patches.

EXSICC. Hep. Bor.-Am. 108, *p. p.* (distributed as *F. Nisqualensis*).

On tree-trunks and old fences, rarely on rocks. Common in the Coast Range Mountains from San Francisco northward. Mission Dolores (Bolander), on "metamorphic sandstone, San Francisco" (Bolander, Apr. 4, 1864), and Clarendon Heights (Howe), San Francisco; Mill Valley and Olema, Marin Co.; Mendocino (Bolander; Howe, 547, 548, 574, 579, 1210, 1211); Eureka (Bolander; Howe, 970). Collected by Dr. A. Kellogg also and by Dr. Bolander, without definite locality.

5. FRULLANIA NISQUALLENSIS Sulliv. Mem. Amer. Acad. II. 4: 175. 1849. Evans, Trans. Conn. Acad. 10: 21. *pl. 10.* 1897.

Reddish-brown, varying to yellowish-green, depressed-caespitose: stems 1.5–3 cm. long, .12–.27 mm. in diameter, usually dark-brown, mostly bipinnate: dorsal lobes of the leaves imbricate, obliquely ovate, those of the main stem and principal branches .63–1.3 mm. × .55–.9 mm., all arching over the stem and cordate at base, entire, the strongly decurved apex acute or more commonly acuminate-apiculate, discolored cells scattered or wanting or rarely in a short median line; lobules oval-cylindrical to short-clavate, .16–.24 mm. × .09–.14 mm., separated from the stem by about their own width; stylus usually minute and subulate: underleaves distant or contiguous, suborbicular or reniform, 1–3½ times the width of the stem, auriculate at base, bifid about ¼ their length with obtuse or sometimes apiculate lobes, the sinus rather broad and obtuse or subacute, margins entire, strongly recurved at least toward the apices of the mostly reflexed and often subcucullate lobes: superior and median cells of the dorsal lobes mostly 16–30 μ, all rather thick-walled, trigones and often intermediate thickenings becoming conspicuous toward the middle: dioicous: androecium ovoid, ♂ bracts 4–9 pairs: archegonia terminal on a short branch: ♀ bracts in about three pairs, deeply and unequally bifid, the dorsal lobes ovate or ovate-lanceolate, acuminate, entire, sinuous, or very sparingly dentate; lobules mostly subulate-acuminate, canaliculate or subtubulose by the recurving of the margins, often falcate or distorted, bearing on the inner side toward the base a small laciniate segment or a cluster of cilia: inmost bracteole connate with bracts on both sides or sometimes on one side only, ovate, bifid ⅓–½ its length with lobes similar to the lobules of the bracts, the margins ciliate or dentate toward the base: perianth long-ovoid, 2–2.5 mm. × .9–1.2 mm., rather gradually narrowed to the short beak, strongly unicarinate ventrally, smooth: capsule exserted by about

s own diameter of .7–.8 mm.; spores 60–100 μ in maximum iameter, verruculose.

On rocks and trunks of trees.

Clarendon Heights, San Francisco (Jan. 23, 1895); Duncan's ills (1209, in part), Sonoma Co.; Mendocino (1223); Kneeland rairie Road (1042), Humboldt Co., near Crescent City, Del Norte Co. (Thomas Howell, April, 1892). The species extends s far north as Vancouver Island (Macoun).

Class ANTHOCEROTES.

The class *Anthocerotes* (see page 9) comprises the single order *Anthocerotales* and the single family *Anthocerotaceae.*

ANTHOCEROTACEAE.

Gametophore a wholly leafless thallus, commonly flat, orbicular, or semiorbicular, more or less lobed or radiately dissected, sometimes subpinnate (*Dendroceros*), or ribbon-shaped and subdichotomously branched, with, or more frequently without, a well-defined costa, usually of several layers of cells, often with interior mucilage cavities, more rarely with intercellular air-spaces, without proper epidermis, but provided on the ventral surface, sometimes also on the dorsal, with inconspicuous clefts ("stomata," "mucilage-slits"), the thallus becoming through these infected with *Nostoc* colonies; cells with a single large chloroplast which commonly encloses the nucleus.

Sexual organs embedded in the thallus; antheridia arising endogenously, short-stalked, single or in groups of 2–4 (rarely more), occupying cavities separated from the dorsal surface by two layers of cells, the covering ruptured at maturity; walls of archegonium confluent with surrounding cells of the thallus, the neck-canal communicating with dorsal surface at maturity of the egg-cell. Special calyptra not differentiated. "Involucre" tubular, of several layers of cells, formed from archegonium-wall and adjacent cells of thallus, usually soon broken through at the apex by the elongating capsule and remaining as a sheath about its base, or (in *Notothylas*) irregularly torn by external agencies.

Sporogonium consisting of a pod-like, usually erect and much elongated capsule, a bulbous foot, and a short intervening zone occupied by a long-active meristematic tissue; capsule dehiscing, with rare exceptions, from the apex downward by two valves, its walls containing chlorophyll and in most species of *Anthoceros* bearing stomata, each with two crescentic guard-cells; a slender thread-like columella, surrounded throughout and covered at the apex by the spore-forming layer, probably always present, but sometimes early disintegrated and obscure. Spores more or less plainly tetrahedral, long adhering in fours, smooth, verrucose, papillate, or echinulate, ripening successively from apex of capsule downward; sterile cells from the archesporium single and subcubical at maturity, or, more often, elongated and forming heteromorphic, variously contorted, occasionally branched fila-

ments of 2–4 cells, sometimes (*Anthoceros* sp. and *Dendroceros*—in tropics and southern hemisphere) with one or more well developed spiral bands, or, more commonly (pseudo-elaters), with spiral thickenings rudimentary or wanting.

Three genera, *Anthoceros*, *Dendroceros*, and *Notothylas*, are ordinarily recognized, of which only the first is known to occur within our limits.

ANTHOCEROS L. Sp. Pl. 1139. 1753. Ex Mich. Nov. Pl. Gen. 10, *pl. 7. f. 1, 2.* 1729.

Thallus suborbicular, variously lobed or irregularly dissected, now and then somewhat ribbon-shaped and subdichotomous, of more than one layer of cells throughout, costa wanting, indistinct, or rarely prominent; monoicous, proterandrous, or sometimes dioicous (?)*; capsule erect, bivalved, much exceeding the involucre in length, usually very long, with stomata (in the North American species). Spores granulose-papillate, tuberculate, or echinulate, rarely nearly smooth; sterile cells (in all our species) without spiral thickenings.

Key to the Species.

Thallus with peduncled tubers from ventral surface. 1. *A. phymatodes.*

Thallus without ventral peduncled tubers.

Spores fuscous or black. 4. *A. fusiformis.*

Spores yellow.

Spores with a few (8–15) crescentic verrucae on convex (outer) surface, or nearly smooth; thallus usually with marginal, sometimes peduncled, glandular-thickenings. 2. *A. Pearsoni.*

Spores thickly granulose-papillate. 3. *A. Carolinianus occidentalis.*

1. ANTHOCEROS PHYMATODES M. A. Howe, Bull Torr. Bot. Club, **25**: 12. *pl. 324, 325.* 1898.

Thallus dark green, blackening on drying, dissected; the segments dichotomous, oblong or linear in sterile plants, broader in the fertile, 4–10 mm. × .5–2.5 mm., prostrate or very slightly ascending at the apices, at first radiate, becoming later intricately entangled, narrowly canaliculate dorsally, with ascending sinuate or repand margins, obtuse, carinate with a broad, thick, very distinct or sometimes obsolescent, naked or sparingly radiulose costa, this occupying nearly the whole of the narrower segments and sending down here and there a fleshy or elongated and slender process (.1–.4

* Certain species of *Anthoceros* have been described as dioicous, yet in a genus of which the best known representatives are proterandrous, and in which the archegonia are observed with so much difficulty, it may be suspected that careful investigation, by modern methods, would show proterandry to obtain in all.

mm. in thickness), terminated by a globose or ellipsoidal tuber, the latter .25–1 mm. in diameter, pale when living, yellowish-brown on drying, becoming finally closely covered with root-hairs; thallus 10–16 cells thick in region of costa, passing gradually or rather abruptly into the more or less extended 5–3-stratose marginal lamina; surface-cells rhombic to rhombic-oblong, 33–66 μ × 20–33 μ, indistinct after drying: involucres separate, cylindrical, 1.7–2 mm. × .5 mm., smooth, truncate, entire or slightly repand at the mouth.

On compact soil in a nearly level open plot about fifty feet north of "The Old Mill," Mill Valley, Marin Co., California (Howe: Mar. 19, 1892, and Feb. 22, 1896; the latter, which bears the involucres, we consider the type). Also collected by Dr. Bolander at "Oakland, on slides near the bay." The few capsules that have been seen are very immature, projecting only about 1 mm. beyond the mouth of the involucre, and it is quite possible that the description of the involucre given above will need some modification on the discovery of fully ripened sporogonia.

It is practically certain that this species is, in part, at least, what Austin referred provisionally to *Anthoceros caespiticius* De Not. (Bull. Torr. Bot. Club, **6**: 26. 1875), drawing his description, however, "from a specimen in herb. Torrey under the name *A. laevis* Linn., from the Island of Corsica." We had thought to take up for *A. phymatodes* the specific name *Torreyi* Aust. MS., which appears in parenthesis after *A. caespiticius* in the place cited, but an examination of the Austin collection, so generously loaned by Mr. Pearson, showed the manuscript diagnosis of *A. Torreyi* affixed to a scrap of the Corsican plant (which we refer to *Anthoceros dichotomus* Raddi) and that plant alone alluded to at the close of the description. *A. Torreyi* Aust. MS. is therefore a synonym of *A. dichotomus* and not of *A. phymatodes*. Bolander's specimen is accompanied by a slip of brown paper on which is written—evidently by himself—"Oakland on slides near the bay," but it is found in the Austin collection glued to Austin's manuscript description of *A. Lescurii* from New Orleans, the evident type of which appears in the same collection under the name of *A. Ludovicianus*.

Anthoceros phymatodes is a near ally of *A. dichotomus* Raddi, specimens of which from Raddi's herbarium we have had the

privilege of examining through the kindness of Professor Massalongo, as well as specimens from Portugal and Italy, obligingly communicated by Herr Stephani. But *A. dichotomus* has a costa 1/8–1/3 the width of the segment, 6–10 cells thick, the lamina mostly 2-stratose, involucre .7–1 mm. wide, often enlarged at the irregularly 2–4-lobed mouth; while *A. phymatodes* has a costa 1/3–3/3 the width of the segment, 10–16 cells thick, the marginal lamina 5–3-stratose, involucre .5–.6 mm. wide, not expanded at the entire or repand mouth. To facilitate further comparison, when the mature sporogonia are found, it may be added that in *A. dichotomus* from Raddi's herbarium ("*Anthoceros polymorphus* Raddi γ *dichotomus* Raddi" is the legend the packet bears) the capsules are erect or slightly curved, 7.5–15 mm. long, often thickened toward the apex, spores yellow, becoming yellowish-brown, rounded-tetrahedral, almost wholly smooth on all faces, 42–60 μ in maximum diameter, pseudo-elaters yellowish, of 1–4 irregular elongated cells, geniculate, variously contorted, often branched.

Anthoceros caespiticius DeNot., the probable original of which (from the vicinity of Cagliari, in southern Sardinia), we have been allowed to study through the indulgence of Professor Pirotta, is not closely related to *A. dichotomus*, with which it was compared by its author. It is a near ally of *Anthoceros punctatus* and may not be specifically distinct. The spores incline to be fuscous and are finely setose-papillate on the outer face and foveolate-reticulate on the inner faces; they are 40–45 μ in maximum diameter. The pseudo-elaters are practically as in *A. punctatus*. The involucres measure .65–1.1 mm. × .25–.5 mm. It is surely very different from the Californian plant, even though mature spores of the latter are wanting. The thallus apparently bears no tubers; it is thinner than in *A. phymatodes*, is quite indistinctly costate, and has the peculiar narrow ascending marginal shoots of *A. punctatus*. It is described by DeNotaris as being erect, while *A. phymatodes* is prostrate.

Anthoceros tuberosus Tayl., from Swan River, Australia (Drummond, 1873), we have examined through the courtesy of Dr. B. L. Robinson, Curator of the Gray Herbarium, in which the Taylor collection is incorporated. It differs from our plant in the much thinner, broader, scarcely costate thallus, the terminal or

marginal tubers, and the shorter somewhat obovate involucres. The spores are yellow, becoming brownish, sparingly warty-granulose, 35–45 μ; pseudo-elaters mostly of 1 or 2 elongated geniculate cells.

Anthoceros phymatodes differs from *Anthoceros Donnellii* Aust. in the larger, less numerous tubers on stouter stalks, also in the thicker, more opaque thallus, with less distinct surface cells, in the longer segments, etc.

The tubers of *A. phymatodes* are formed at the apex of the costa, but their peduncles become strictly ventral in their attachment by the continued onward growth of the segment. Two or three tubers successively older and larger as one passes backward may often be seen depending from a single branch. The tuber consists of a cortex of 2–4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or nearly colorless granules that the cell boundaries in a section are rendered obscure.

An interesting paper, "On the Structure and Contents of the Tubers of *Anthoceros tuberosus* Taylor" was published in the Memoirs and Proceedings of the Manchester [Eng.] Literary and Philosophical Society, vol. 41, no. 2 (1896) by Mr. J. H. Ashworth. Mr. Ashworth finds oil-drops and proteid granules in the interior cells of the tubers of this species. We have stated (Bull. Torr. Bot. Club, 25: 14. 1898) that the granules in the tubers of *Anthoceros phymatodes*, in material preserved in alcohol, show a starch reaction with iodine, but further tests upon the same material either fail entirely to show the starch reaction or show it so obscurely that we must doubt the accuracy of our first observation. The granules mostly contain one or two more highly refringent portions, as described by Mr. Ashworth in *A. tuberosus*, and, on the application of iodine, they usually are stained a yellowish-brown or remain altogether unaffected.

PLATES 117 AND 118. ANTHOCEROS PHYMATODES.

1. Portion of the thallus, natural size.

2. Ventral view of a thallus segment, showing costa and tuber, × 23.

3–6. Lateral views of thallus segments, showing form and stages of development of tubers, × 23.

7 and 8. Old tubers, showing vegetative propagation by sprouting, × 23.

9. Longitudinal section through costa and young tuber, × 47.

10. Longitudinal section showing early stages in the formation of the tuber, 47. The section is somewhat oblique and does not exhibit the full thickness of the sta.

11. Section through a well-grown tuber, × 53.

12. A single interior cell from fig. 11, × 305.

13. Longitudinal section through the costa, × 53.

14 and 15. Transverse sections of thallus segments, × 53.

16. Outlines of two other transverse sections of thallus segments, × 23.

17. Involucres, × 12.

Figs. 1–6 and 9–17 from specimen collected in Mill Valley, Marin Co., February , 1896—mostly drawn from material fixed with 1% chromic acid and preserved in cohol; 7 and 8, from same locality, March 19, 1892.

18. Involucre of *Anthoceros polymorphus* Raddi, γ *dichotomus* Raddi, ex herb. addi, × 12.

. ANTHOCEROS PEARSONI M. A. Howe, Bull. Torr. Bot. Club, **25**: 8. *pl. 322, 323.* 1898.

Thallus smooth, prostrate or ascending, rarely erect, mostly regularly dissected; the major segments linear or elongate-flabelform, 5–20 mm. × 1–5 mm., often intertangled, sparingly lobed r two or three times subradiately dichotomous, plane or slightly oncave, rarely costate ventrally at apices, in sterile plants usually –11 cells thick, gradually or abruptly reduced to three or four at ie margin, in the fertile commonly expanded into a wide 3- or 2-ratose lamina with a lightly crisped periphery, the lobes in both ften terminating in dark green, globose or difform, glandular-ickenings, .2–2 mm. in diameter, these sometimes long-peduncled, irely descending and radicelliferous; surface-cells rather distinct, iombic-trapezoidal to oblong, 20–70 μ × 20–30 μ, the inner larger ut compact; *Nostoc* colonies usually abundant, ellipsoidal or fusi-orm: monoicous: involucres solitary or approximate in pairs, ibterminal in erect forms, somewhat pellucid, mostly light green, ongate-cylindrical, 2.3–3.3 mm. × .5–.85 mm., sometimes decum-ent at base, the mouth entire, repand-dentate, often lacerate with ge, now and then scarious: capsule pale brown, yellowish, or drab, ender, sulcate, 8–32 (mostly 20–24) mm. × .24–.4 mm., rather iick-walled, the valves finally thin and often twisted, stomata abun-ant; columella filiform, naked; spores yellow, the convex face with few (8–15) small, crescentic, rarely obsolete warts, otherwise nooth or most faintly granulose, 35–50 μ in maximum diameter; seudo-elaters dilute yellow or occasionally tinged with brown, of –4 cells, geniculate and variously contorted, often branched, the ells 30–80 μ × 6–10 μ, with wall of nearly uniform thickness.

On moist banks and dripping rocks. Mill Valley (no. 16, Iay 7, 1892—the type—and 1205), Olema—also collected in

Marin Co., by Dr. Bolander and by T. S. Brandegee; Duncan's Mills (1198, 1200) and Cazadero (1199) Sonoma Co.; Mendocino (587, 702); Deer Creek Cañon, Russ and Graham's Ranch (1070) Humboldt Co.; near Douglas City (1202), Trinity Co.; Oak Run, Shasta Co. (Baker and Nutting); Mitchell's Cañon, Mt. Diablo (1201); Berkeley (1204); Palo Alto (Prof. D. H. Campbell); Santa Monica (Dr. H. E. Hasse); San Bernardino (Mr. S. B. Parish, 1731, 2220).

Anthoceros Pearsoni is the commonest yellow-spored *Anthoceros* of California, and perhaps of the Pacific Coast as a whole. We have seen as many as twenty specimens, ranging from southern California to Washington, and they are always very clearly distinct from *Anthoceros laevis* L., *A. Carolinianus* Michx., and *A. Hallii* Aust.; differing from the last-mentioned in having the capsule usually four times as long, in the much more perfect pseudo-elaters, composed of 1–4 elongated cells, in the spores being scarcely otherwise roughened than by 8–15 small crescentic verrucae, etc.; very different from both *A. laevis* and *A. Carolinianus*, in the character of the spore-markings, the spores of the two latter species being always thickly granulose-papillate. Sterile conditions can sometimes be only doubtfully distinguished from *A. Hallii*, but can be separated from glandular-thickened forms of *A. Carolinianus occidentalis* by the narrower segments and often peduncled glands. The species is extremely variable in thickness and form of thallus, though very constant in spore-markings. In its thicker, slightly costate conditions, particularly when the glandular-thickenings are long-stalked, descending, and tuber-like, the thallus bears some resemblance to that of *A. phymatodes*, but in all such cases, we believe, the attachment of the tubers never becomes strictly ventral; their peduncles can, with care, always be traced back to the margins of the frond. The glands or tubers are 10–25 cells in thickness and consist of a more or less distinctly defined capsule of 1–3 layers of undifferentiated cells enclosing cells containing at first an unusually large chloroplast and later filled with oil-drops or densely crowded with whitish granules. These organs are evidently food reservoirs, adapting the thallus to persistence through the dry summers of the region that the plant inhabits. In the neighborhood of San Francisco the

thickenings begin to appear in January or February, attaining full development in May or June. In our no. 702, collected near Mendocino, California, these marginal thickenings often enclose numerous antheridia.

The above description of *Anthoceros Pearsoni* is based upon various specimens, but our no. 16, collected at Mill Valley, Marin County, May 7, 1892, from which the figures of the spores, pesudo-elaters and capsules have been drawn, we consider the type of the species.

PLATES 119 and 120. ANTHOCEROS PEARSONI.

1. Segment of the thallus, with mature sporogonia, natural size.

2, 3 and 4. Portions of a sterile thallus, showing its form, manner of branching and the beginnings of the marginal glandular-thickenings, natural size.

5. Marginal glandular-thickenings, fully developed, × 12.

6 and 7. Thallus segments with younger, sometimes peduncled, glandular thickenings, × 12.

8. Ventral view, showing glandular-thickening bearing root-hairs, × 12.

9 and 10. Longitudinal sections through well-developed glandular-thickenings, the latter exhibiting embedded antheridia, × 53.

11. Transverse section of margin of the thallus, × 53.

12. Median longitudinal section of the thallus, × 53.

13–15. Involucres, × 12.

16. Pseudo-elaters, × 225.

17. Spores, × 305.

Figs. 1, 13, 16 and 17 from no. 16, Mill Valley, Marin Co. (the type); 2–4, near Duncan's Mills, Sonoma Co. (no. 1200); 5, 9, 10, 14 and 15, near Mendocino (no. 702); 6 and 7, Cazadero, Sonoma Co. (no. 1199); 8, Palo Alto (Prof. D. H. Campbell); 11 and 12, Mill Valley, Feb. 22, 1896.

3. ANTHOCEROS CAROLINIANUS OCCIDENTALIS M. A. Howe, Bull. Torr. Bot. Club, **25**: 8. *pl. 321.* 1898.

Thallus large, thin, ecostate, usually densely caespitose, ascending, now and then with margins and lobes glandular-thickened, light- or dark-green, a little pellucid or, on drying, opaque with a somewhat fatty lustre, dissected; major segments oblong or obovate, 1–3 times subdichotomously branched, 8–30 mm. × 2–7 mm., more or less widened at the rounded crenate apex, 4–8 cells thick in the middle, passing gradually into a wide 3- or 2-stratose margin, or nearly uniform throughout; surface-cells distinct in terrestrial forms, obscure in the aquatic, irregularly rhombic, becoming elongate-hexagonal, 20–120 μ × 18–30 μ: monoicous: involucres sometimes united in pairs, thick-walled, somewhat pellucid, long-cylindrical, 2–6.5 mm. × .5–1 mm., sometimes contracted or now

a little widened toward the thin, subentire or repand-dentate, rarely scarious mouth, often longitudinally plicate toward the base: capsule slender, 25–50 mm. × .25–.5 mm., pale brown, short-pedicellate, the valves twisted; spores yellow, thickly granulose-papillate, especially on the convex (outer) face, 35–56 μ in maximum diameter; pseudo-elaters nearly colorless to light yellowish-brown, of 1–4 cells, geniculate, often branched, the cells extremely variable in size and form.

On wet rocks and on the banks of rivulets near the water-line.

Olema (Jepson), Mt. Tamalpais, with *Fissidens grandifrons* (Howe, Setchell); Howell Mt., Napa Co. (Setchell); North Fork of Little River, Mendocino Co.; near Eureka, Humboldt Co.; Santa Cruz Mts. (Underwood); San Bernardino Mts. (Parish); near Pasadena (McClatchie); Twin Oaks, San Diego Co. (Koch).

A. Carolinianus differs from *A. laevis* L., chiefly in greater size of the thallus, in the longer involucres, scarcely expanded, sometimes contracted, at the mouth, and in the (typically) more slender capsules. The species as a whole is perhaps to be looked upon as an aquatic or semi-aquatic analogue of *A. laevis*, from which it is probably not always distinct. It, however, departs so widely from the ordinary conception of *Anthoceros laevis* and is usually so easily recognizable that we think it has a fair claim to specific recognition.

The var. *occidentalis* differs from the *Anthoceros Carolinianus* Michx. of the Southern States in the usually more densely caespitose ascending thallus, sometimes forming, when growing, wide cushions 3–4 cm. in depth, while that of the typical *A. Carolinianus* is commonly prostrate; in the occasionally glandular-thickened margins and lobes; and in the less slender capsule. In the glandular-thickened forms of this variety, involucres which seem abnormally shortened and incrassate (2–2.5 mm. × 1 mm.) are often found intermingled with the longer. Such involucres commonly have scarious mouths.

PLATE 121. ANTHOCEROS CAROLINIANUS OCCIDENTALIS.

1 and 2. Portions of the thallus, natural size.
3–5. Involucres, × 12.
6. Segment of thallus with marginal glandular-thickening, × 6.
7. Transverse section of thallus segment (showing but one half the width), × 23
8. Spores, × 305.
9. Pseudo-elaters, × 225.

Figs. 1–3, 8 and 9 from a specimen collected near Olema, Marin Co. (Mr. W. L. Jepson); 4 and 6, Twin Oaks, San Diego Co. (Mr. F. W. Koch); 5, Howell Mountain, Napa Co. (Prof. W. A. Setchell); 7, Mt. Tamalpais, Marin Co.

4. ANTHOCEROS FUSIFORMIS Aust. Bull. Torr. Bot. Club, **6**: 28. 1875.

Thallus in depressed rosettes 6–20 mm. in diameter, or often suberect and caespitose in tufts 5–20 mm. deep, thick and rather rigid, opaque and blackened when dry, undulate-crisped, deeply and irregularly dissected, ecostate, cavernose within, 10–25 cells thick in median parts, becoming rather abruptly 3- or 2-stratose at margin, often with large and abundant glandular-thickenings, more or less lamellate-cristate, lacunose, the lamellae sometimes broad and leaf-like; surface-cells somewhat distinct, subquadrate to oblong-hexagonal, 30–75 μ × 18–40 μ, with large chloroplast, inner cells much broader and longer in axile and basal parts, but often scarcely larger toward the growing apices: monoicous: antheridia in groups of 2–4: involucres often numerous and crowded, but very rarely with the bases united in pairs, subfusiform or narrowly cylindrical, often curved, 2–9 mm. × .35–1.2 mm., smooth, furrowed, or rarely lamellate, mouth repand or scarious and erose-lacerate: capsule dusky brown to black, 2–9 cm. (mostly 3–6 cm.) × .25–.5 mm., rather long-pedicellate, valves commonly a little twisted on drying, stomata abundant, the guard-cells nearly colorless; spores dark-brown or black, 45–63 μ in maximum diameter, angular, the convex face with very numerous (125–225) spines or papillae less than 3 μ in length, plane faces granulose-papillate or sinuate-foveolate; pseudo-elaters fuscous, 60–250 μ × 8–14 μ, of 1–4 cells, geniculate and variously contorted, sometimes branched.

EXSICC. Hep. Am. 163.

On moist banks. Common on the Pacific Coast from southern California to British Columbia.

Mill Valley (15, 1208), Ross Valley (1207); Ukiah (774), Pieta (808), near Mendocino (616 in part, 630b, 664); Eureka (935); Douglas City, Trinity Co. (1137); Palo Alto (Campbell); Felton, Santa Cruz Co. (Farlow); bank of Kaweah River, Tulare Co. (Coville and Funston, Death Valley Expedition, no. 1294—a specimen with unusually abundant and foliaceous lamellae); Devil's Cañon, San Bernardino Mountains (Parish, 2305), near Rochester (Parish); Pasadena (McClatchie); San Diego (Orcutt).

Anthoceros fusiformis is a close ally of *A. punctatus* L., differing in the larger, thicker, more dissected, and usually more lamel-

late-cristate thallus, the rarely geminate, often longer involucres, the longer capsules, the rather larger, more minutely and thickly echinulate or papillate spores, and in the logner, narrower elaters. In the southern part of California it makes its nearest approach to *A. punctatus*, but may be distinguished from that species after a little experience by the characters of the spores and elaters. The involucres in the Californian plants are rarely more than 5 mm. long. *A. fusiformis* ripens its spores in California in April and May, at which time the thallus has commonly become shriveled and inconspicuous.

Following Austin's original description of *Anthoceros fusiformis* three specimens are cited, as follows: "Observation [Observatory] Inlet, Columbia, Dr. Scouler in herb. Torrey; also in herb. Taylor. California, Bolander. Oregon, E. Hall." What appear to be these three originals are preserved in herb. Pearson. Hall's specimen is marked "R. Mts., Hall," but this manner of giving the habitat of Hall's Oregon Hepaticae is observed elsewhere in the Austin collection.

PLATE 122. ANTHOCEROS FUSIFORMIS.

1. Plant, natural size.
2. Portion of thallus, × 23
3. Anterior margin of thallus-segment in vertical section, × 53.
4 and 5. Dorsal lamellae in vertical section, × 53.
6. Nearly median longitudinal section of thallus-segment, × 53.
7–9. Involucres, × 12.
10. Vertical longitudinal section near thallus-apex, showing antheridia and archegonia, × 53.
11. Spores, × 305.
12. Pseudo-elaters, × 305.

Figs. 1 and 9 drawn from no. 1207 (Ross Valley, Marin Co.); 2, from no. 1208 (Mill Valley, Feb. 22, 1896); 3–6, and 10, from microtome sections of material collected in Ross Valley; 7, from no. 808 (Pieta, Mendocino Co.); 8, from a specimen collected in California by Dr. Bolander; 11 and 12, from no. 15 (Mill Valley).

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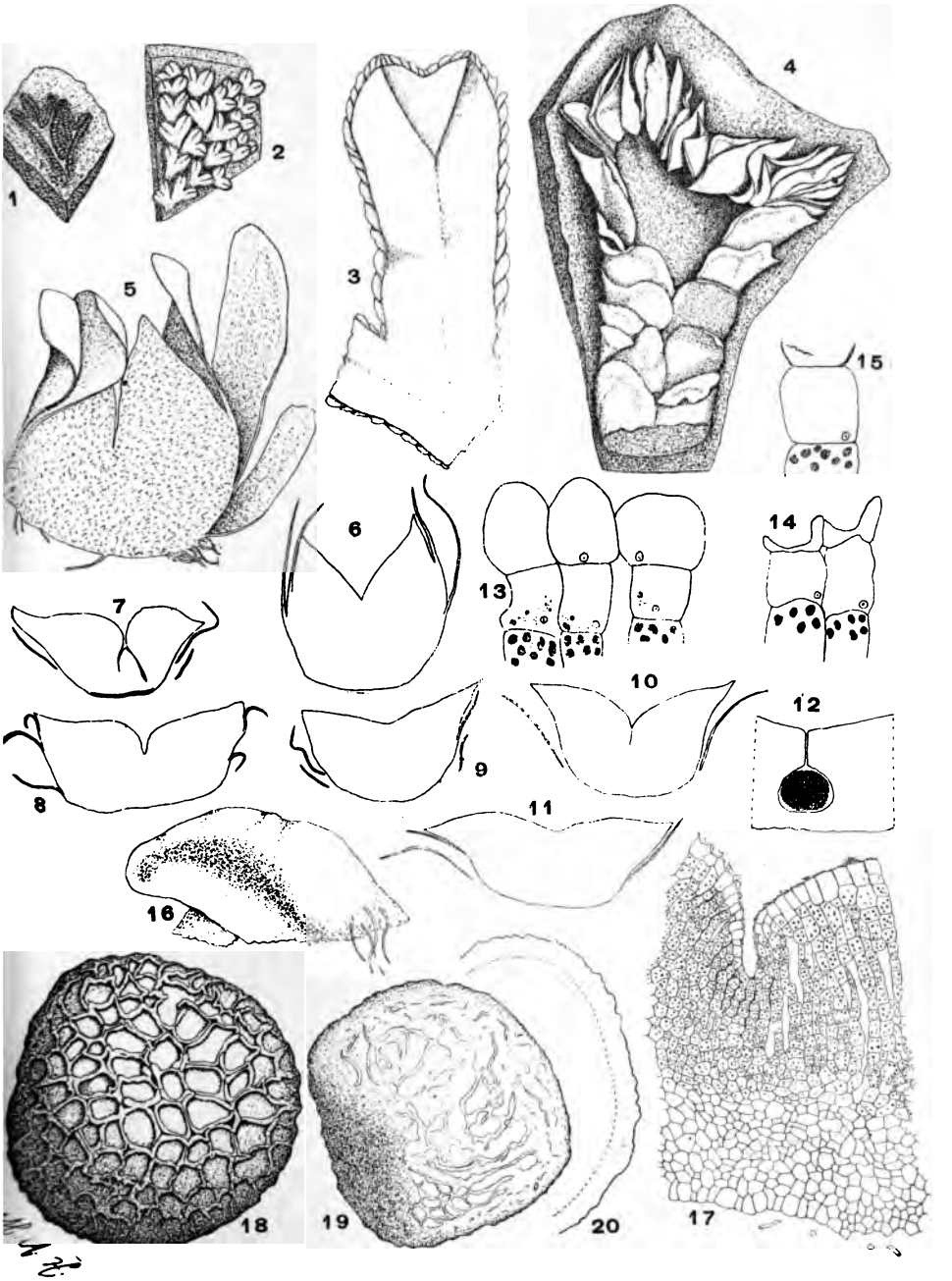

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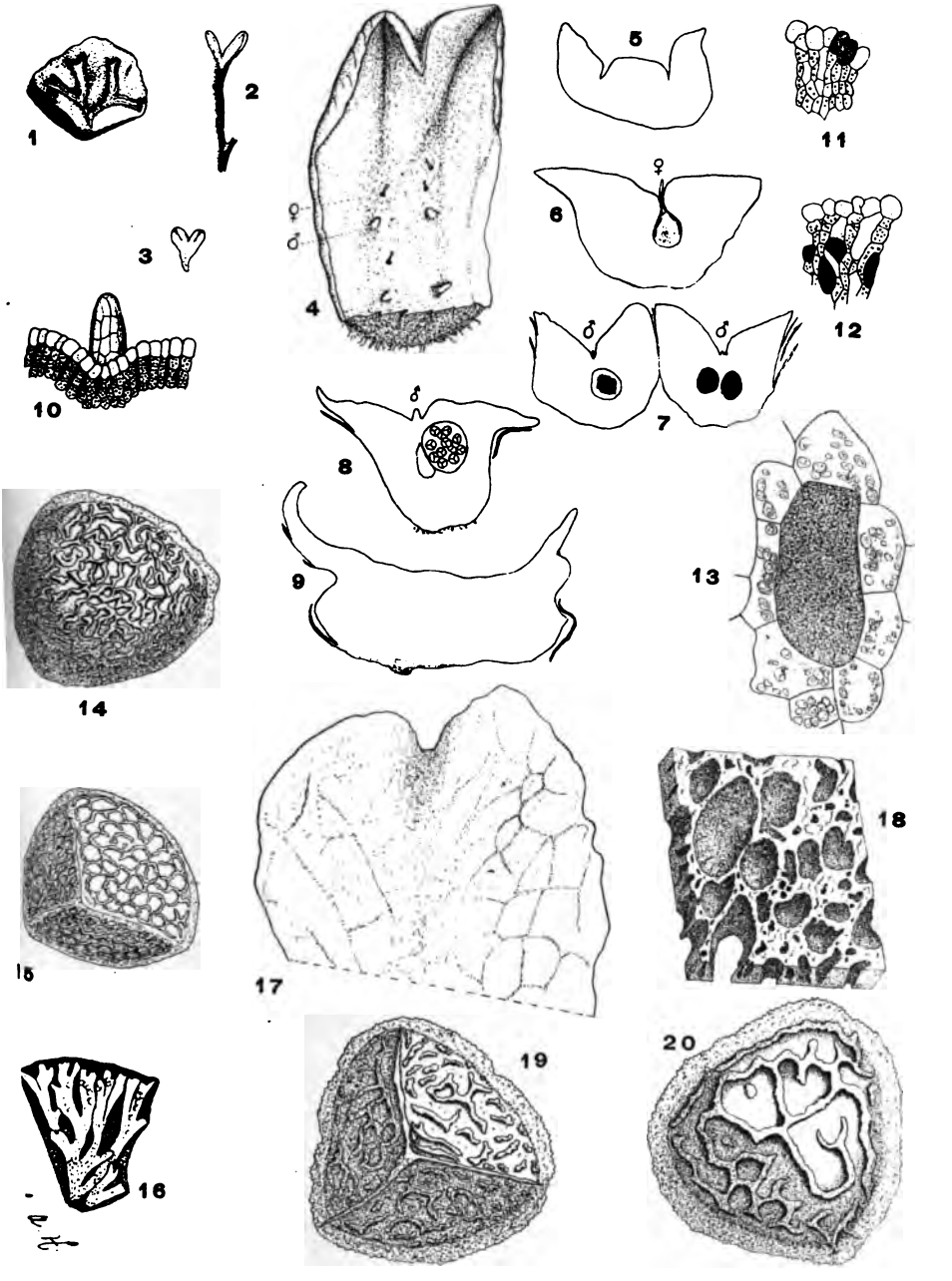

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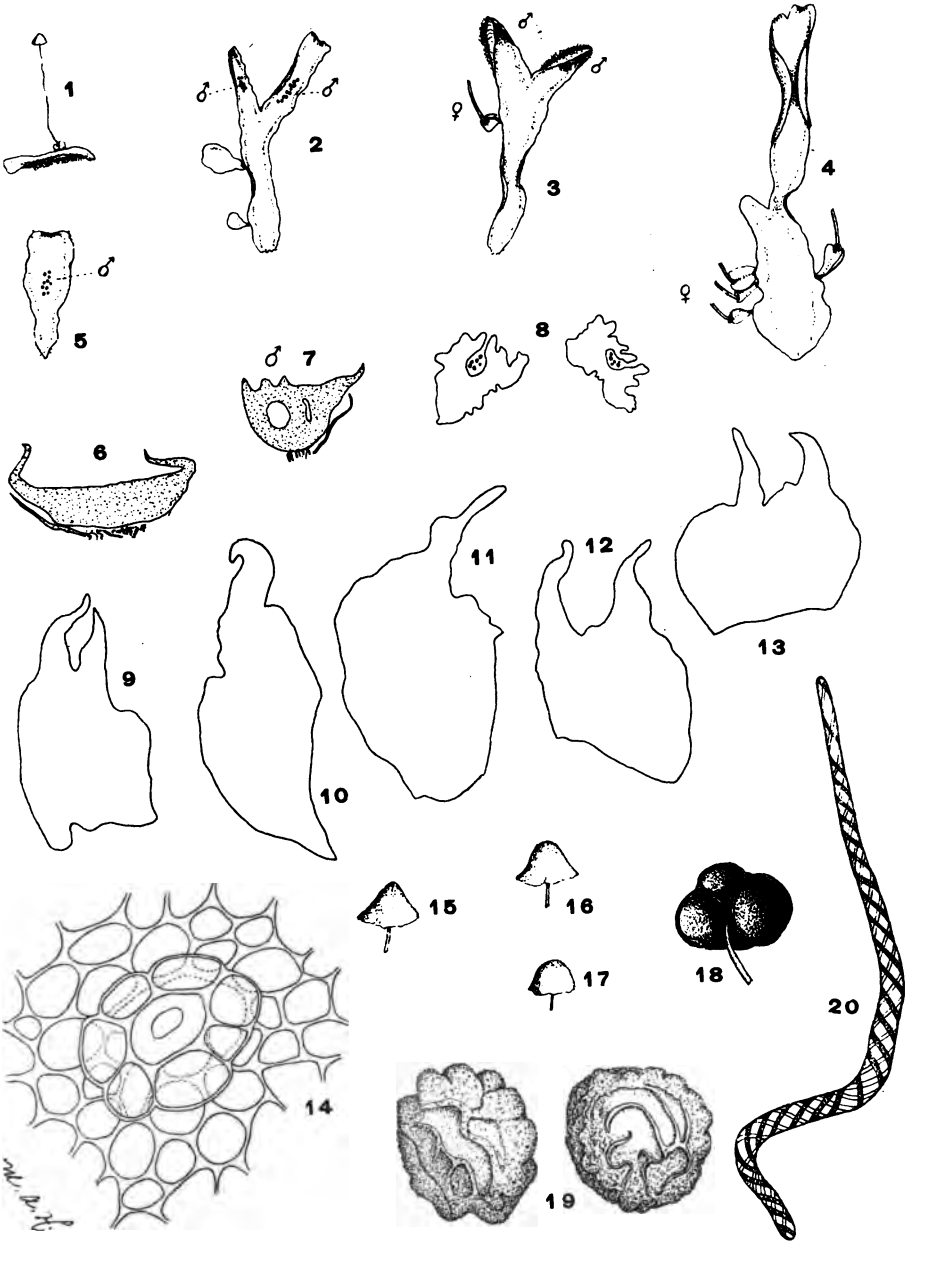

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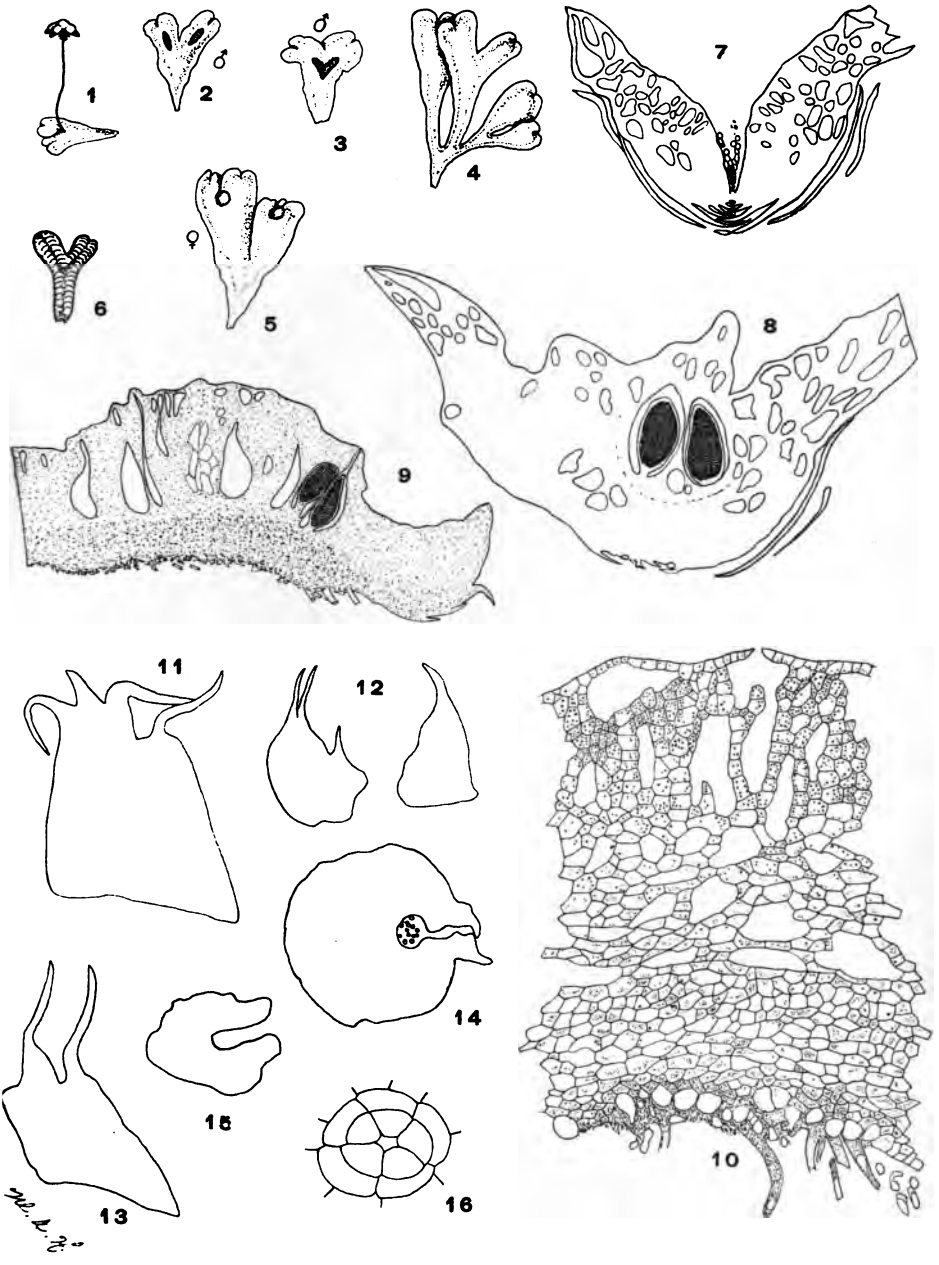

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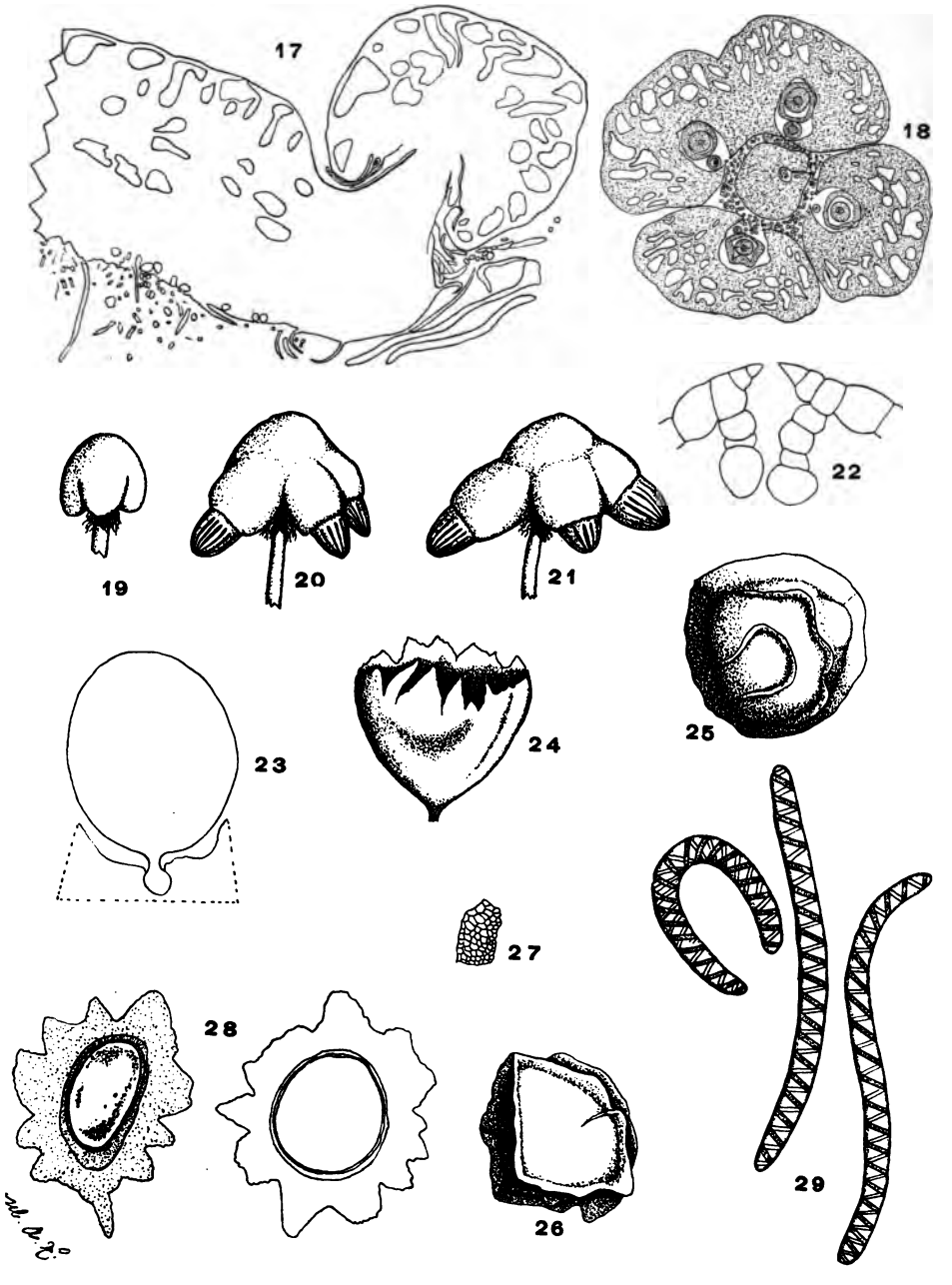

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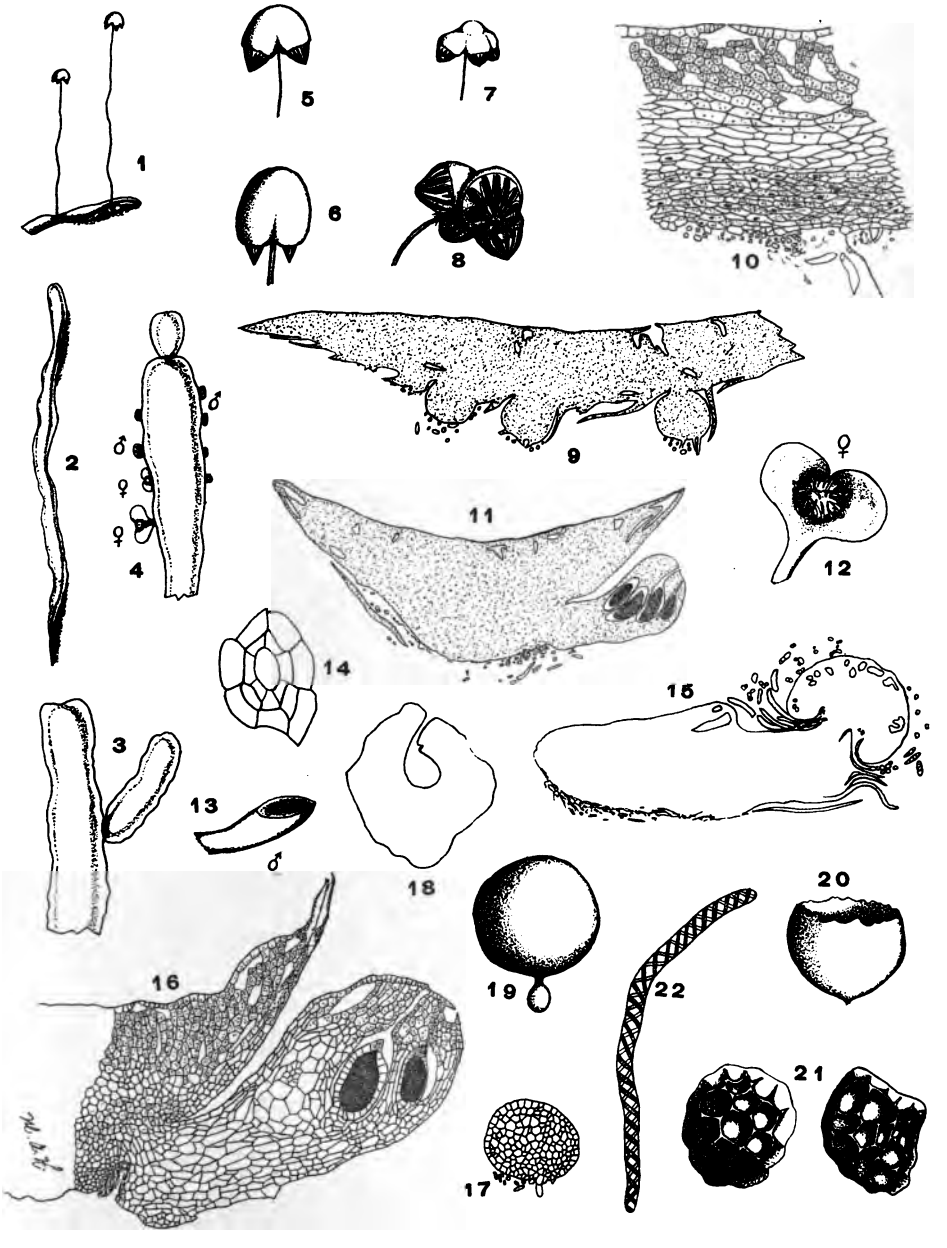

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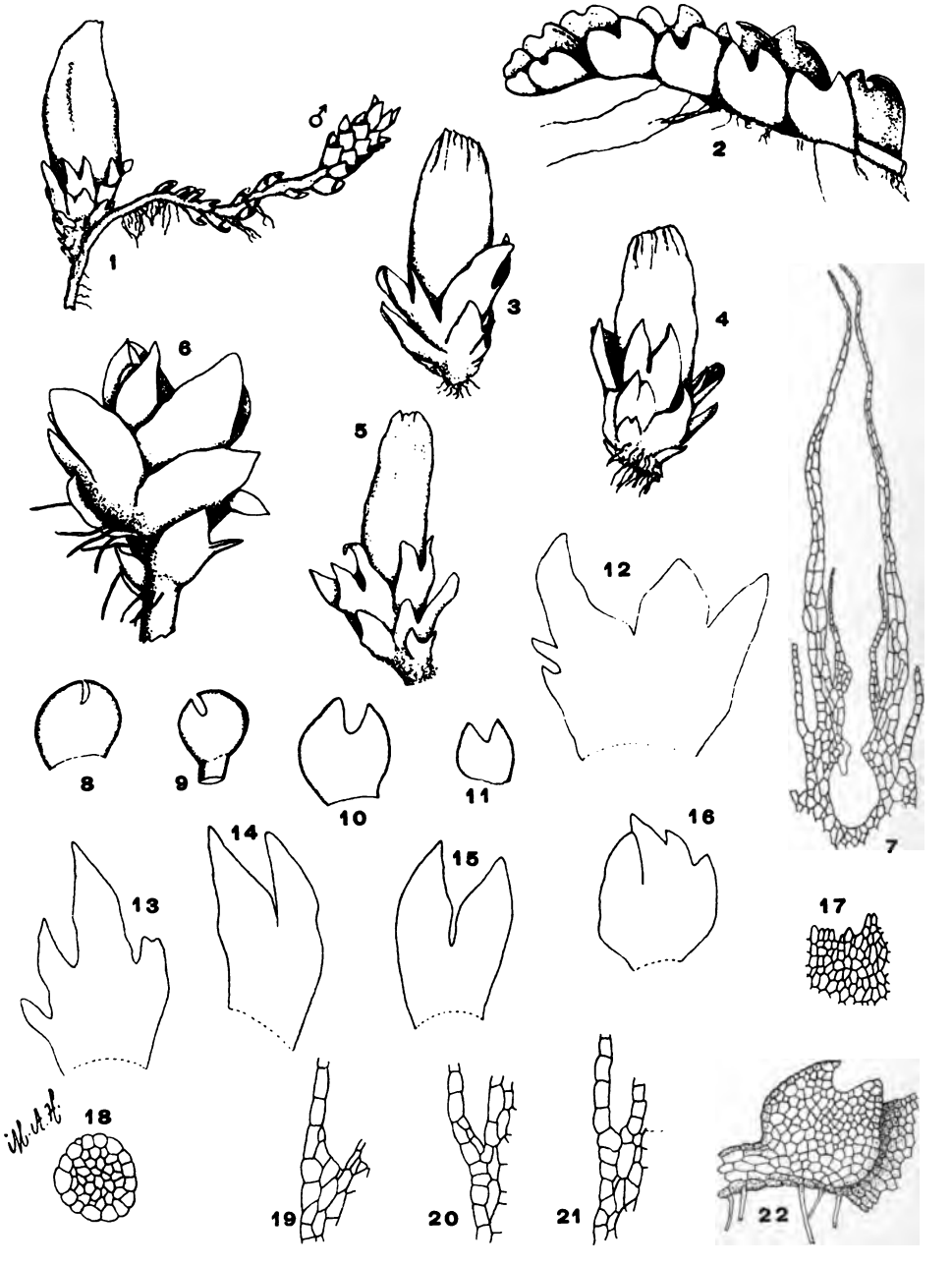

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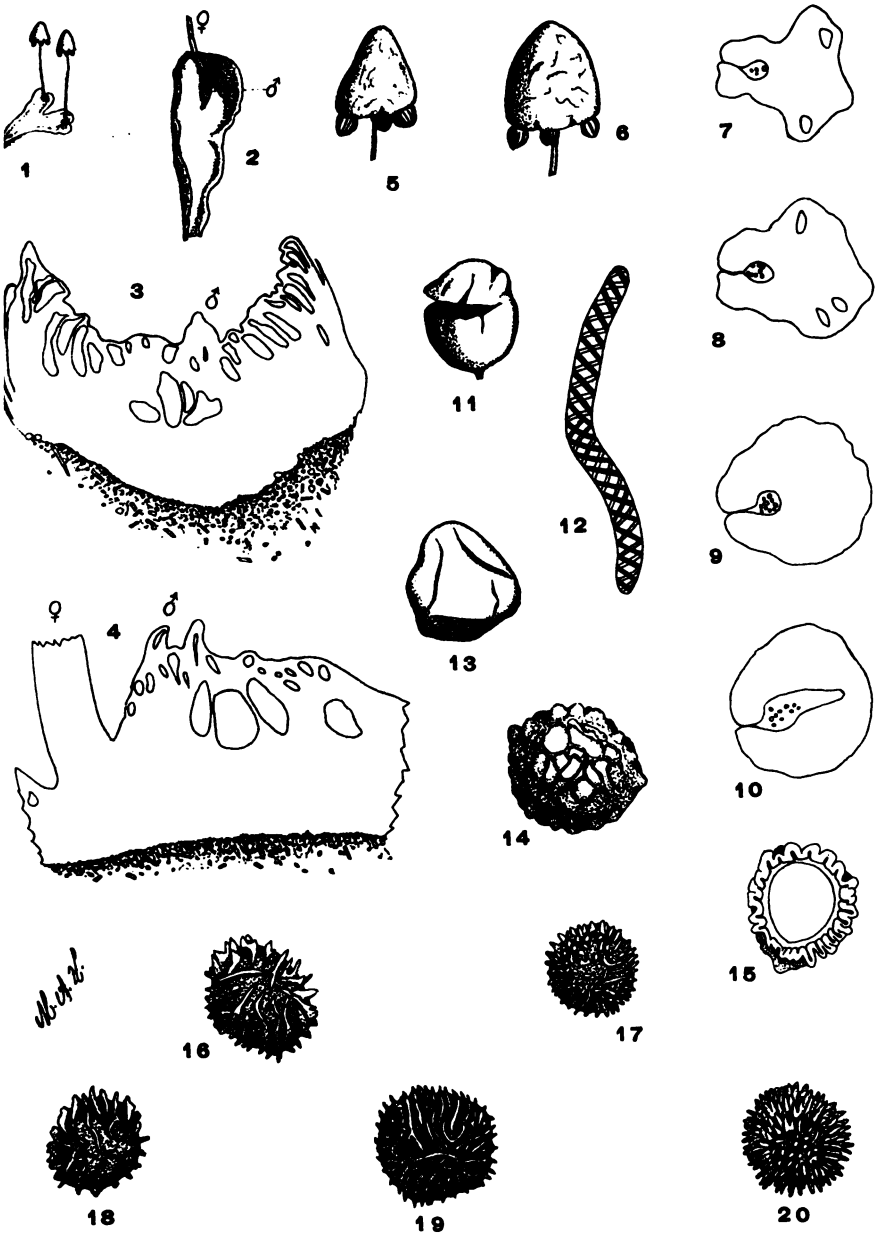

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16–20. FOSSOMBRONIA LONGISETA Aust.

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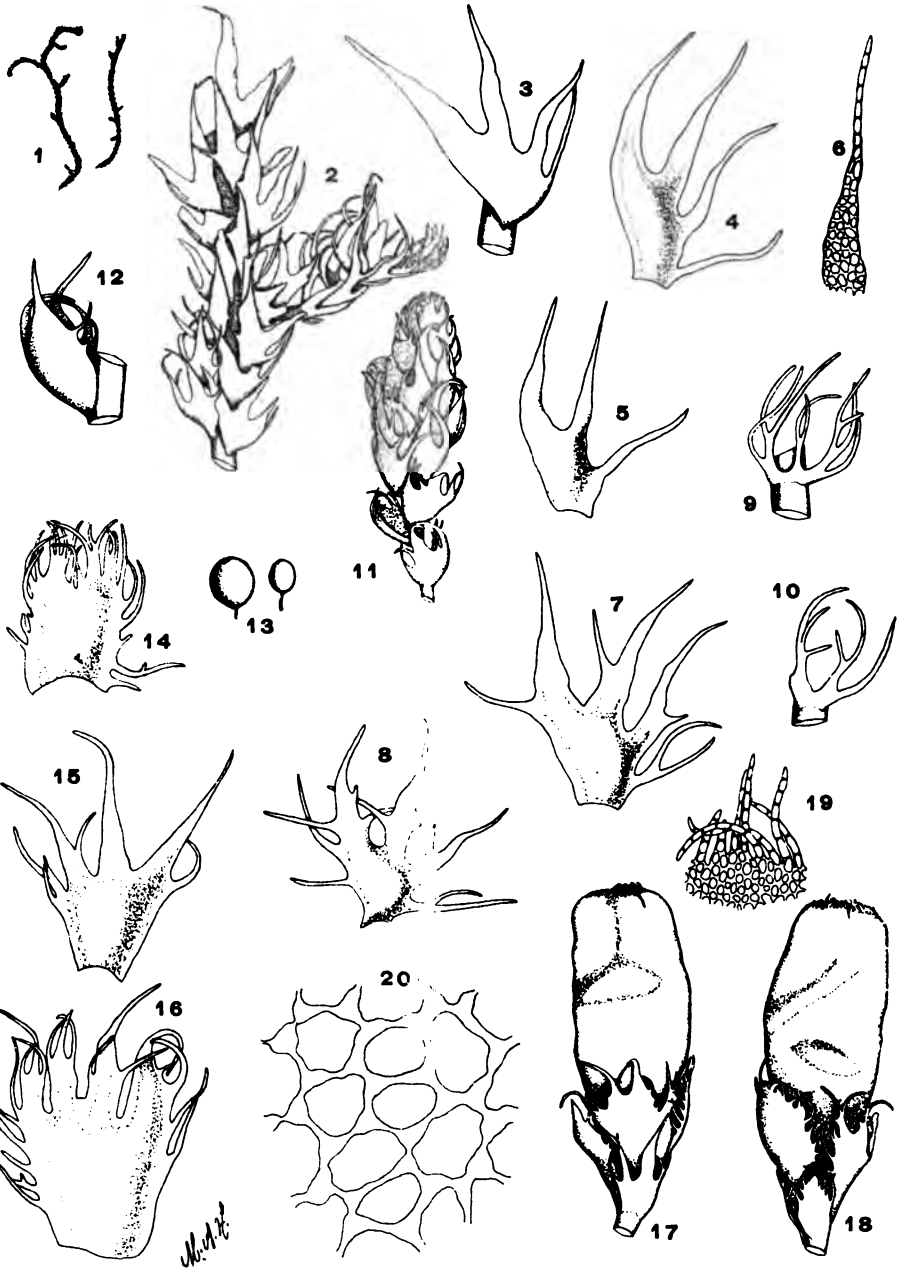

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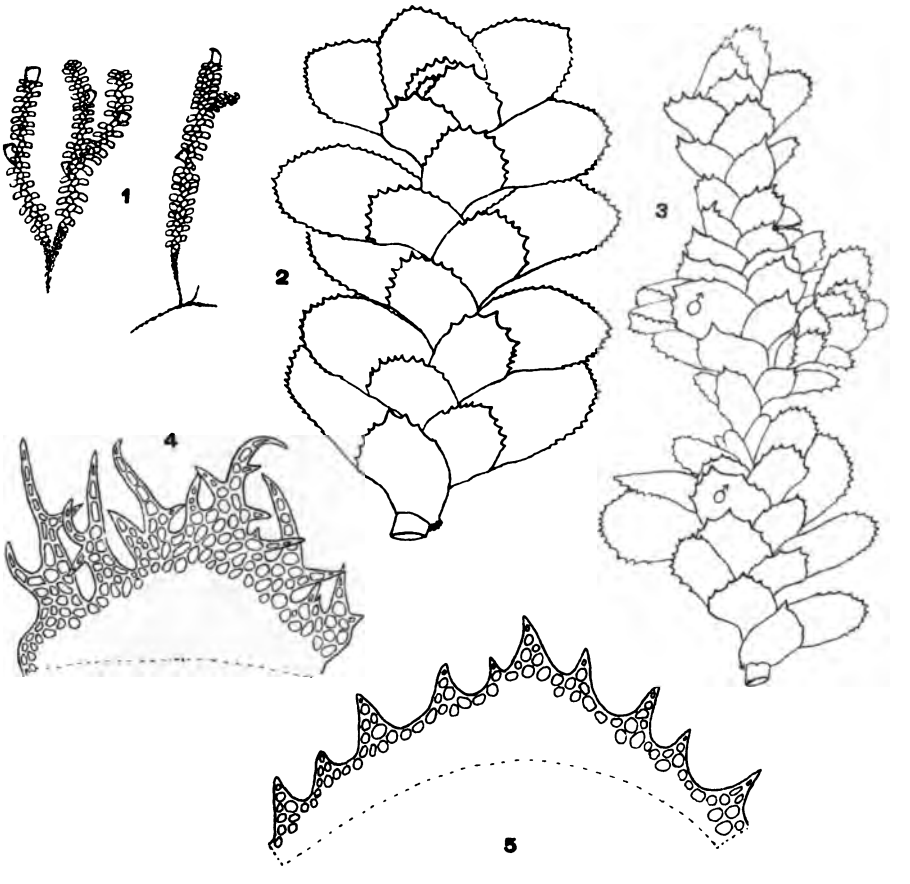

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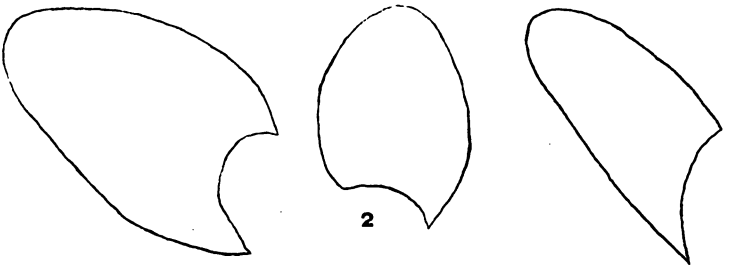

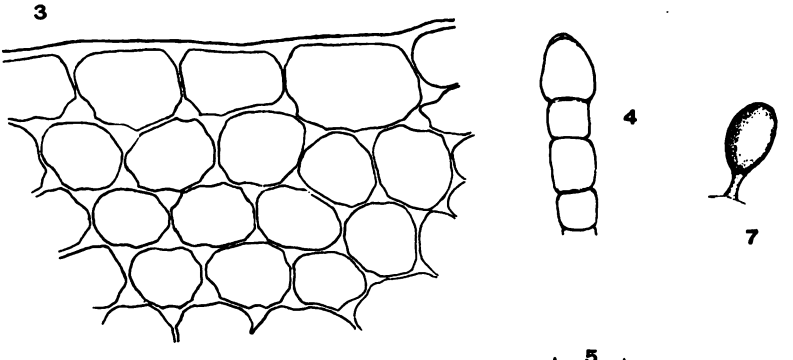

GYROTHYRA UNDERWOODIANA M. A. Howe.

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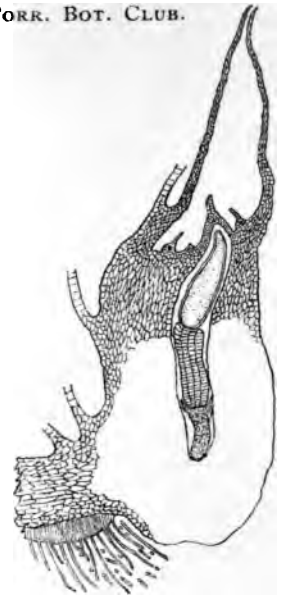

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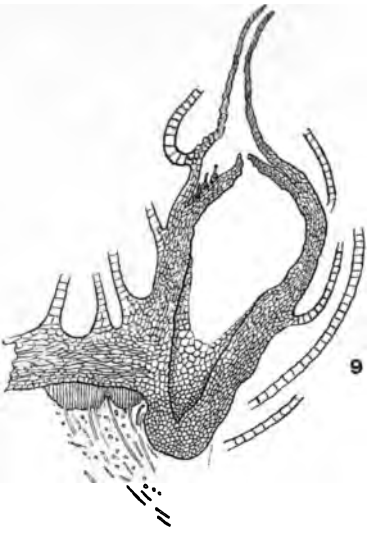

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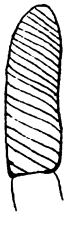

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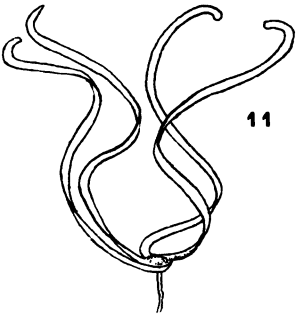

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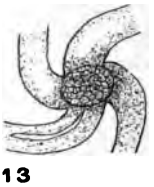

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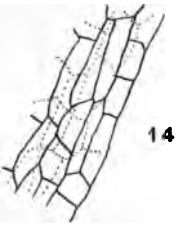

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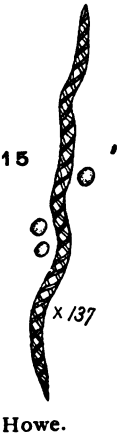

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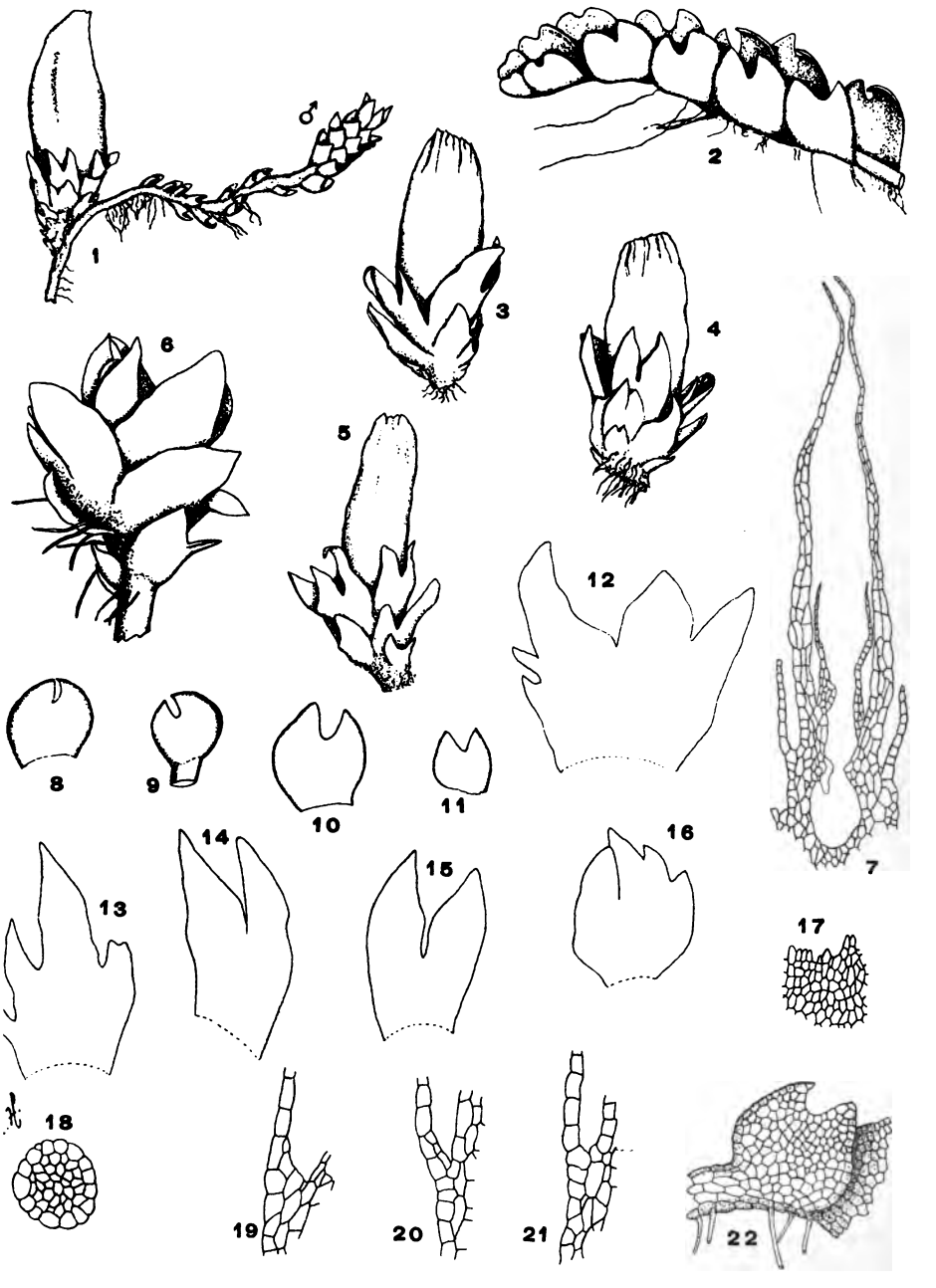

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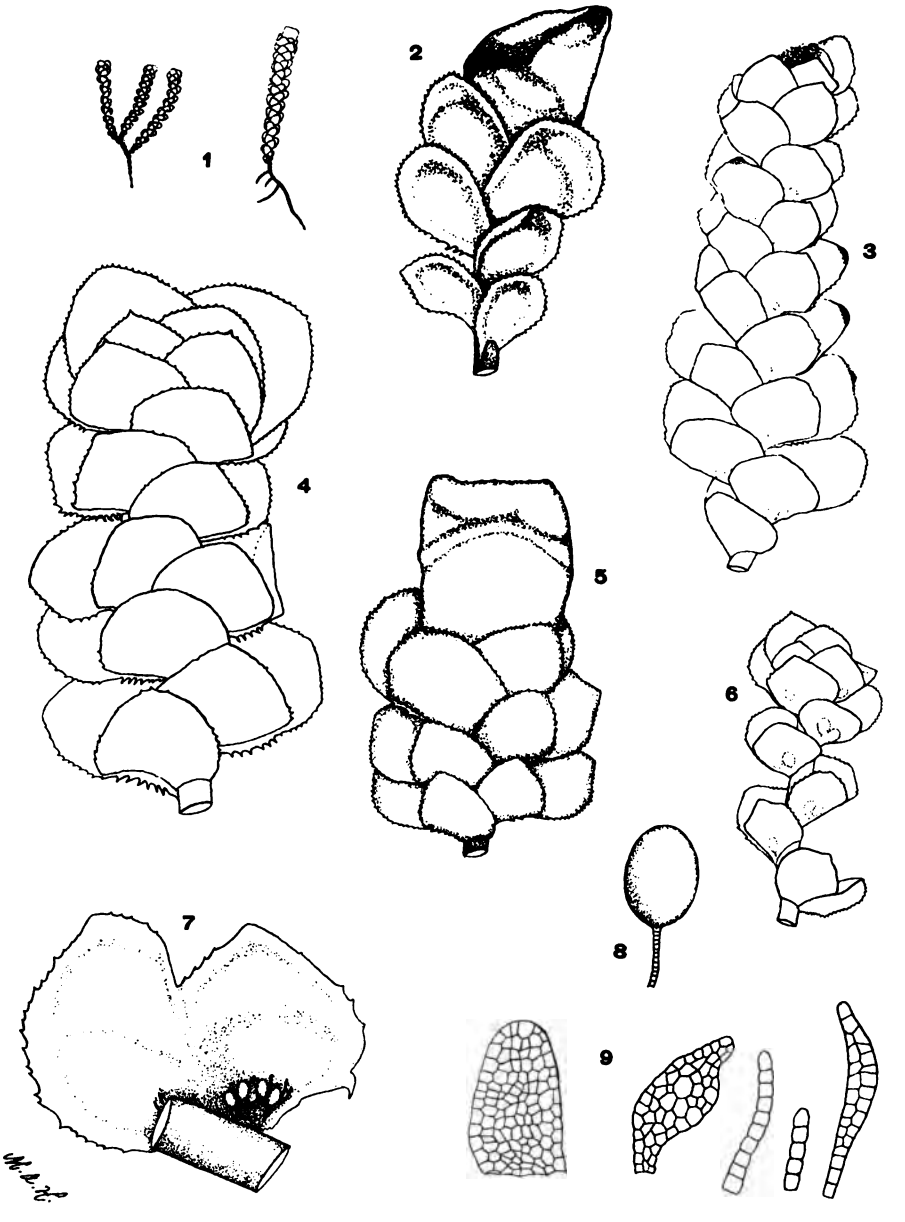

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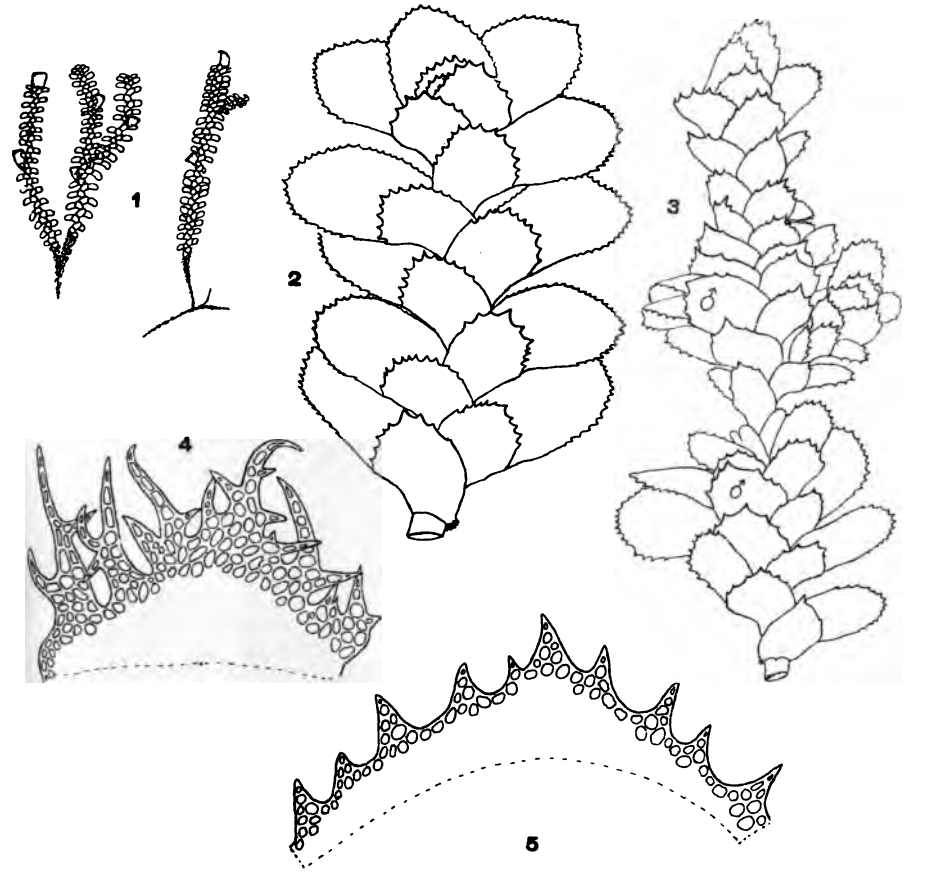

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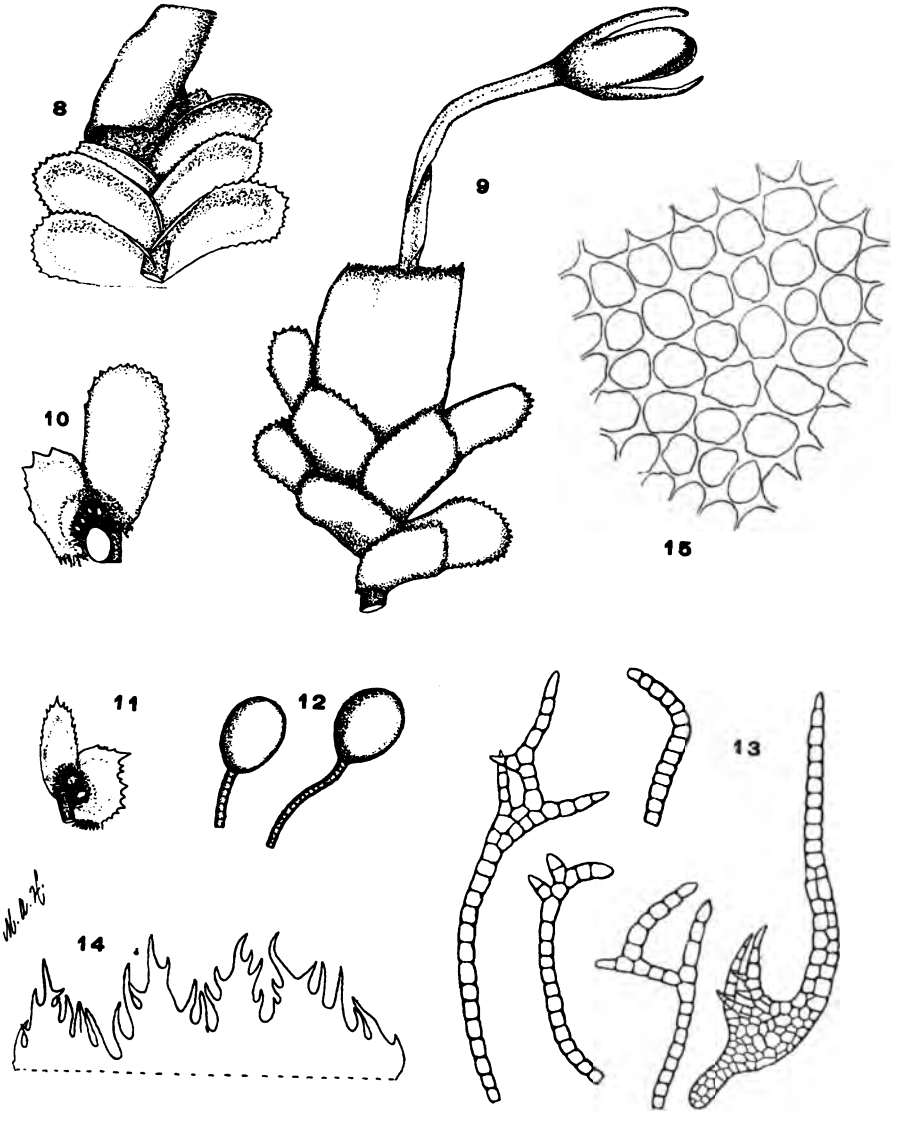

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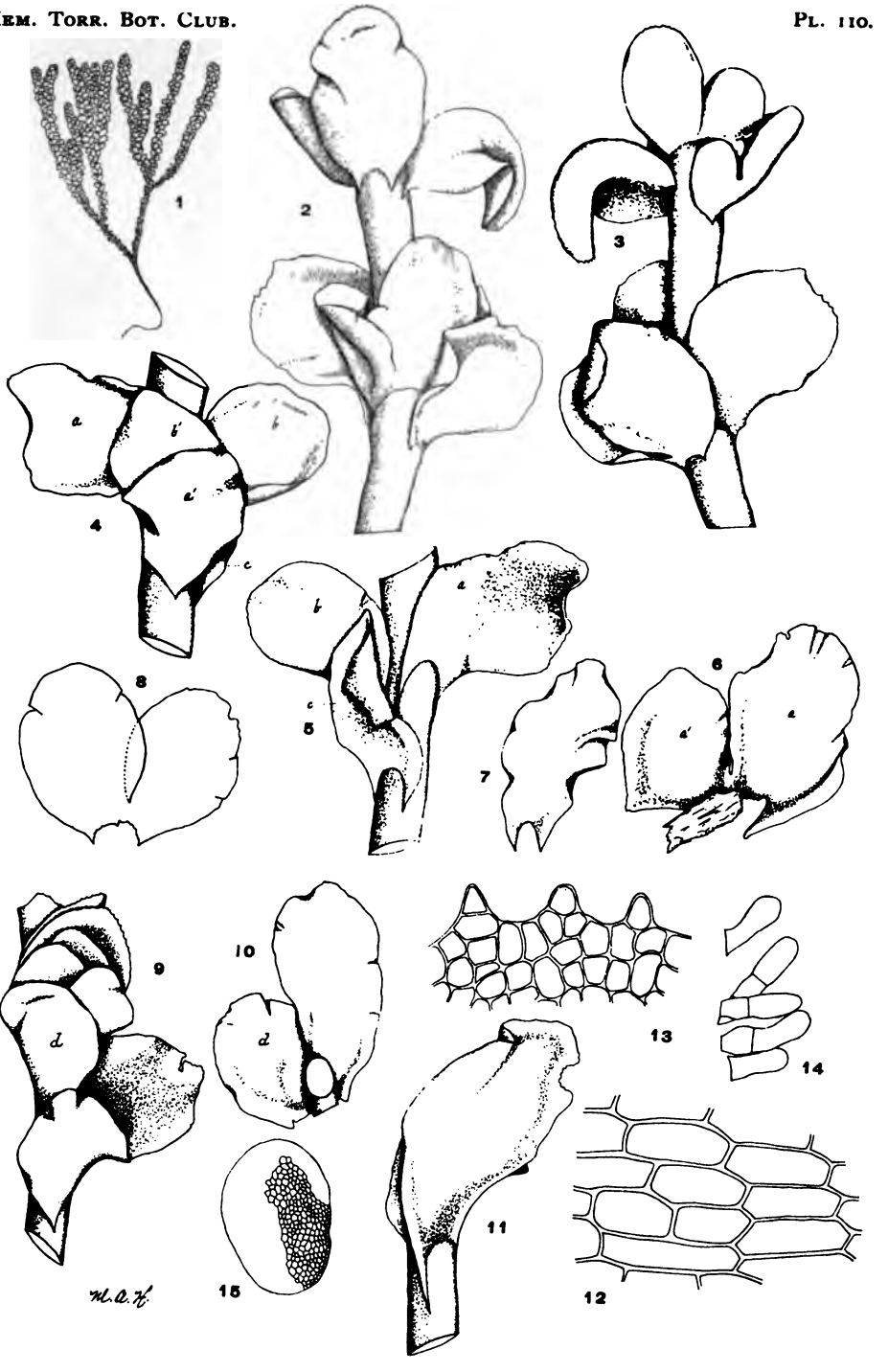

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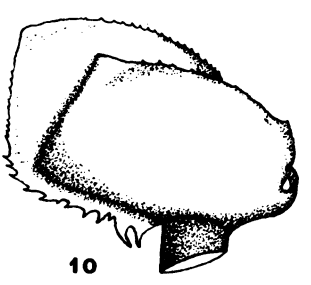

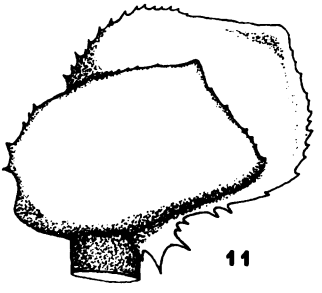

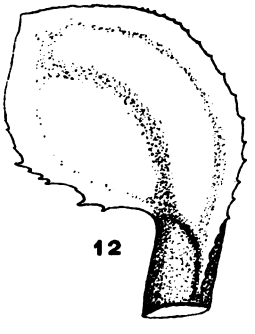

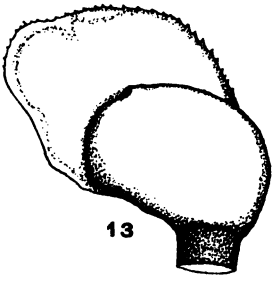

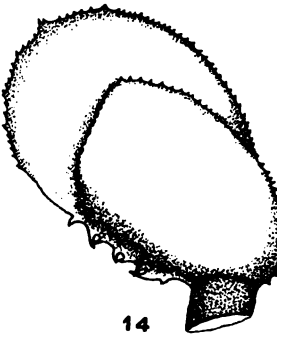

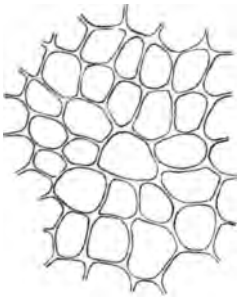

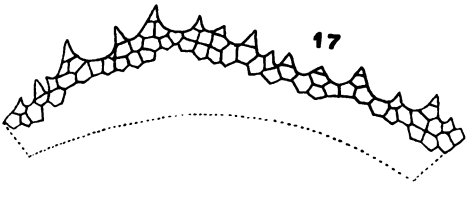

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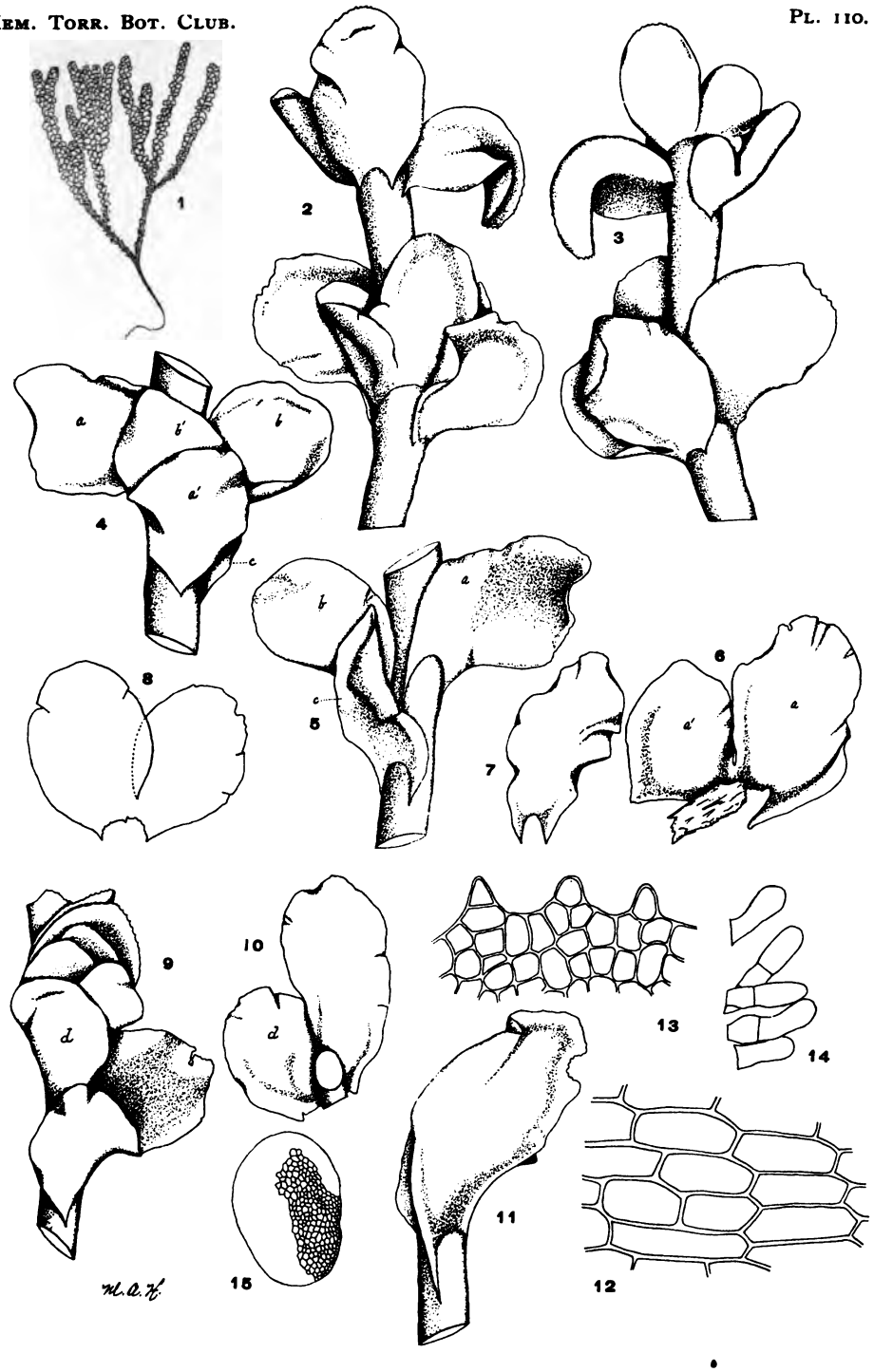

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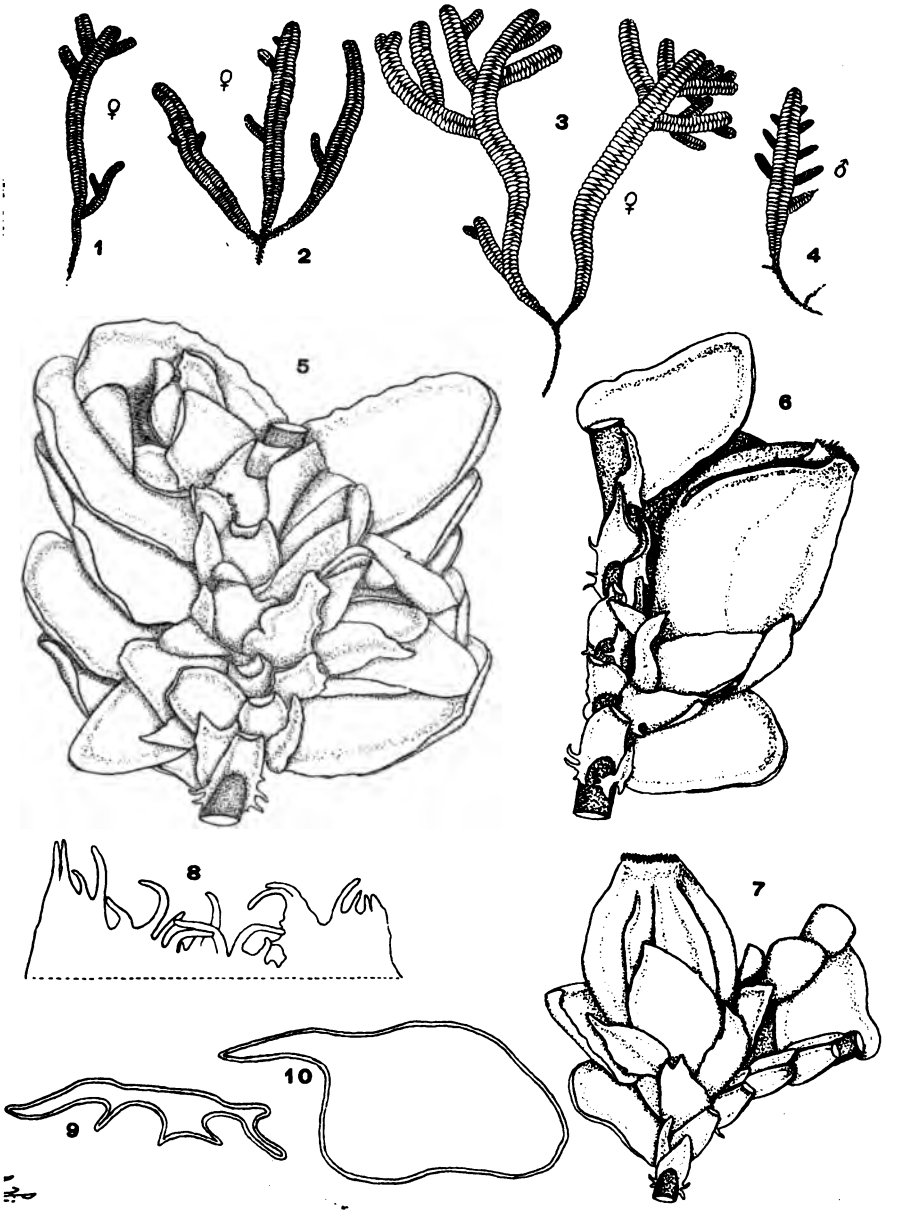

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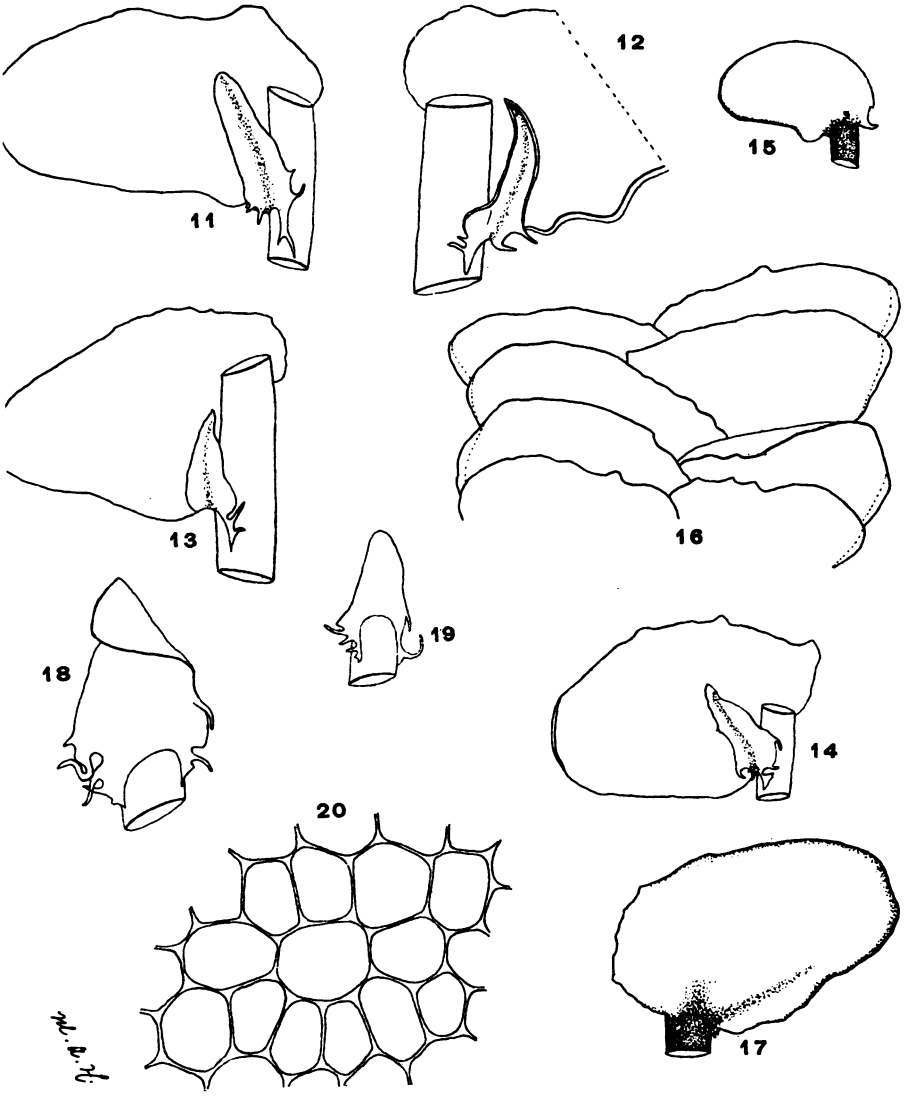

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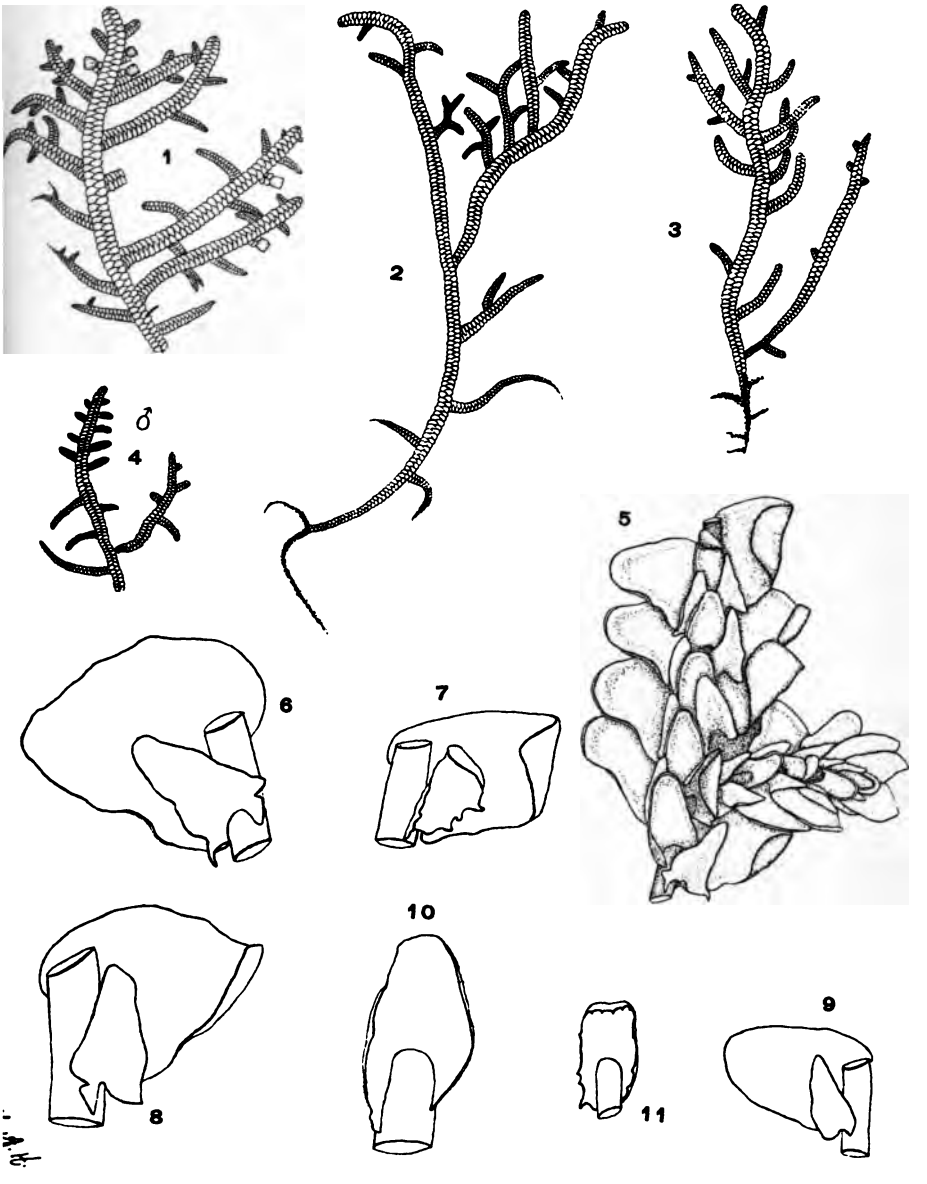

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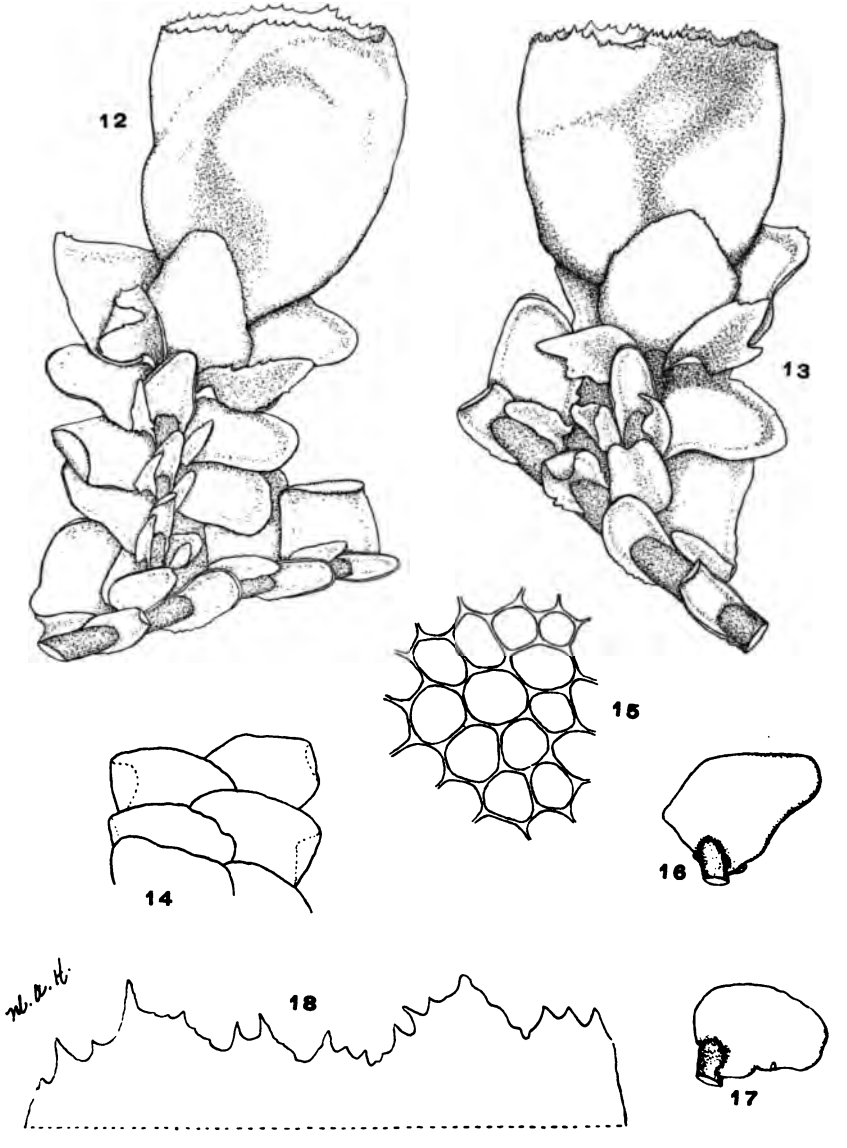

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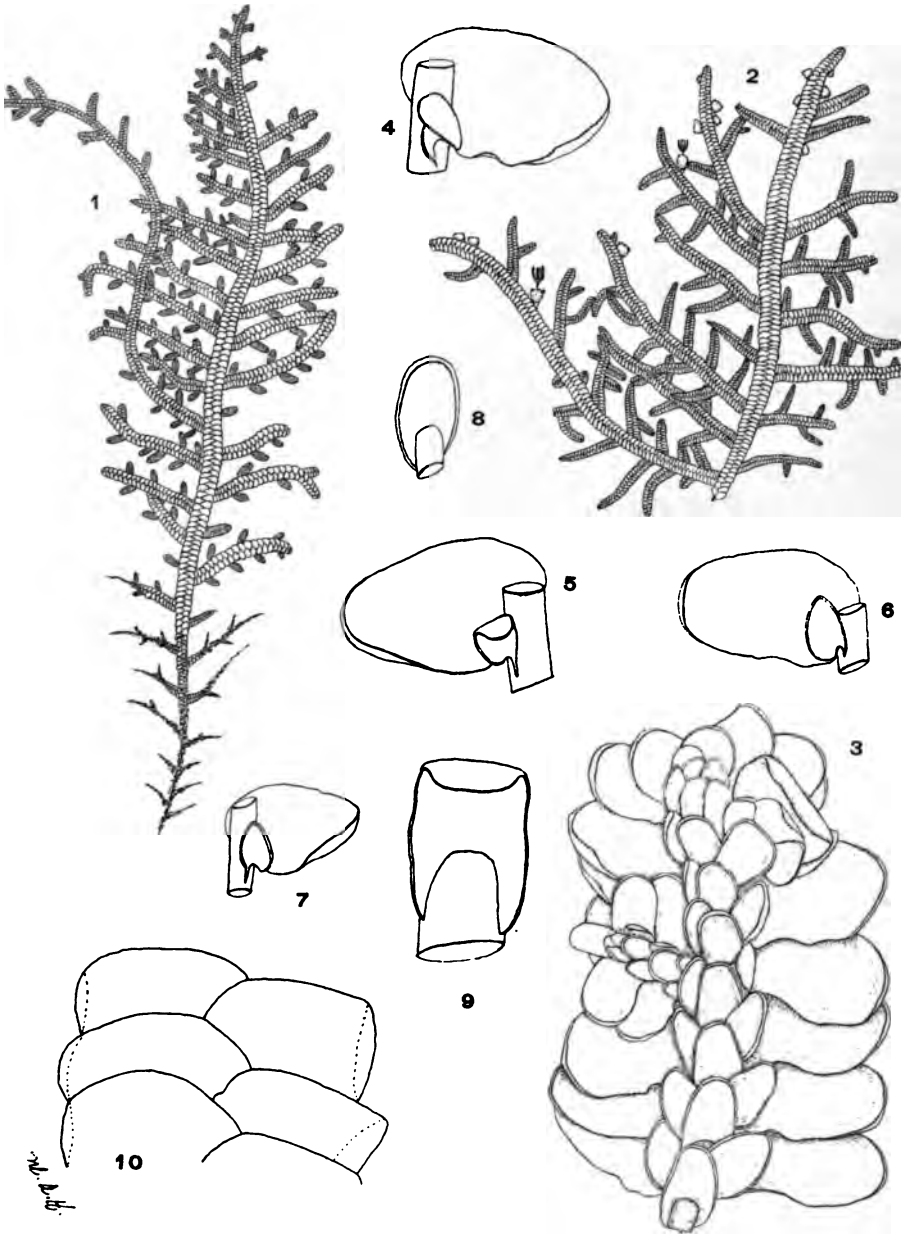

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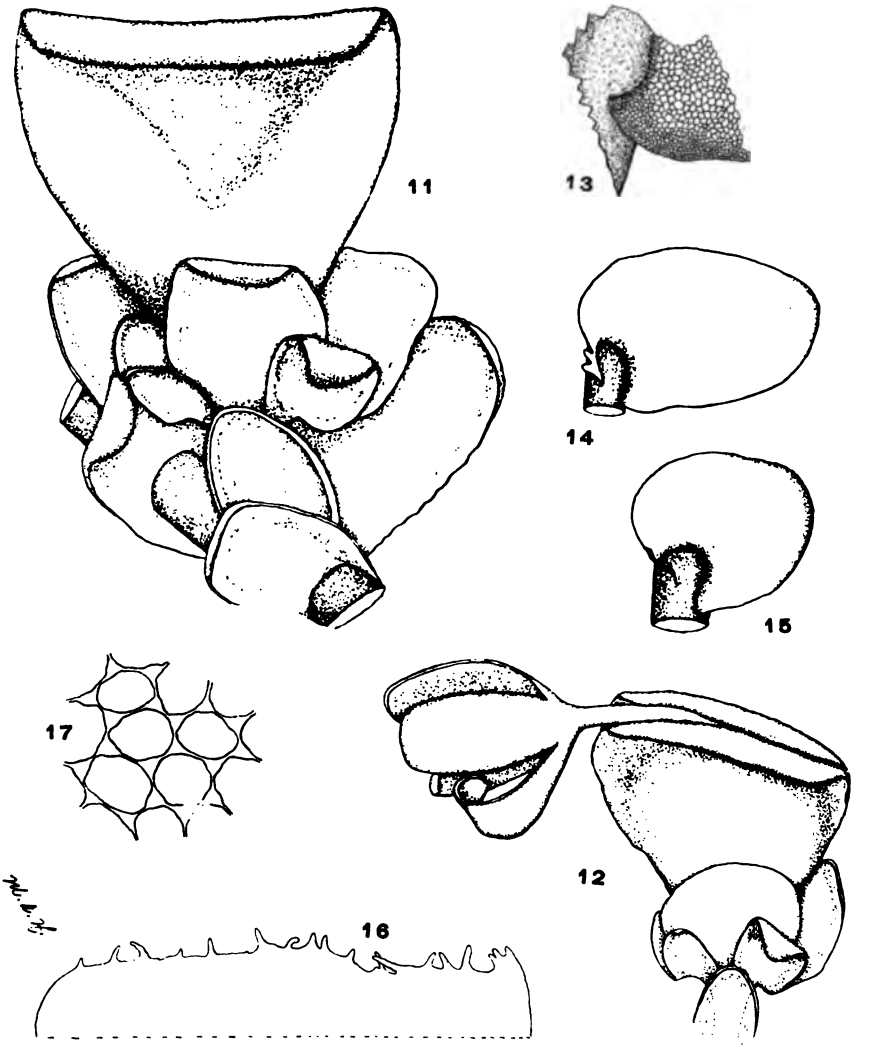

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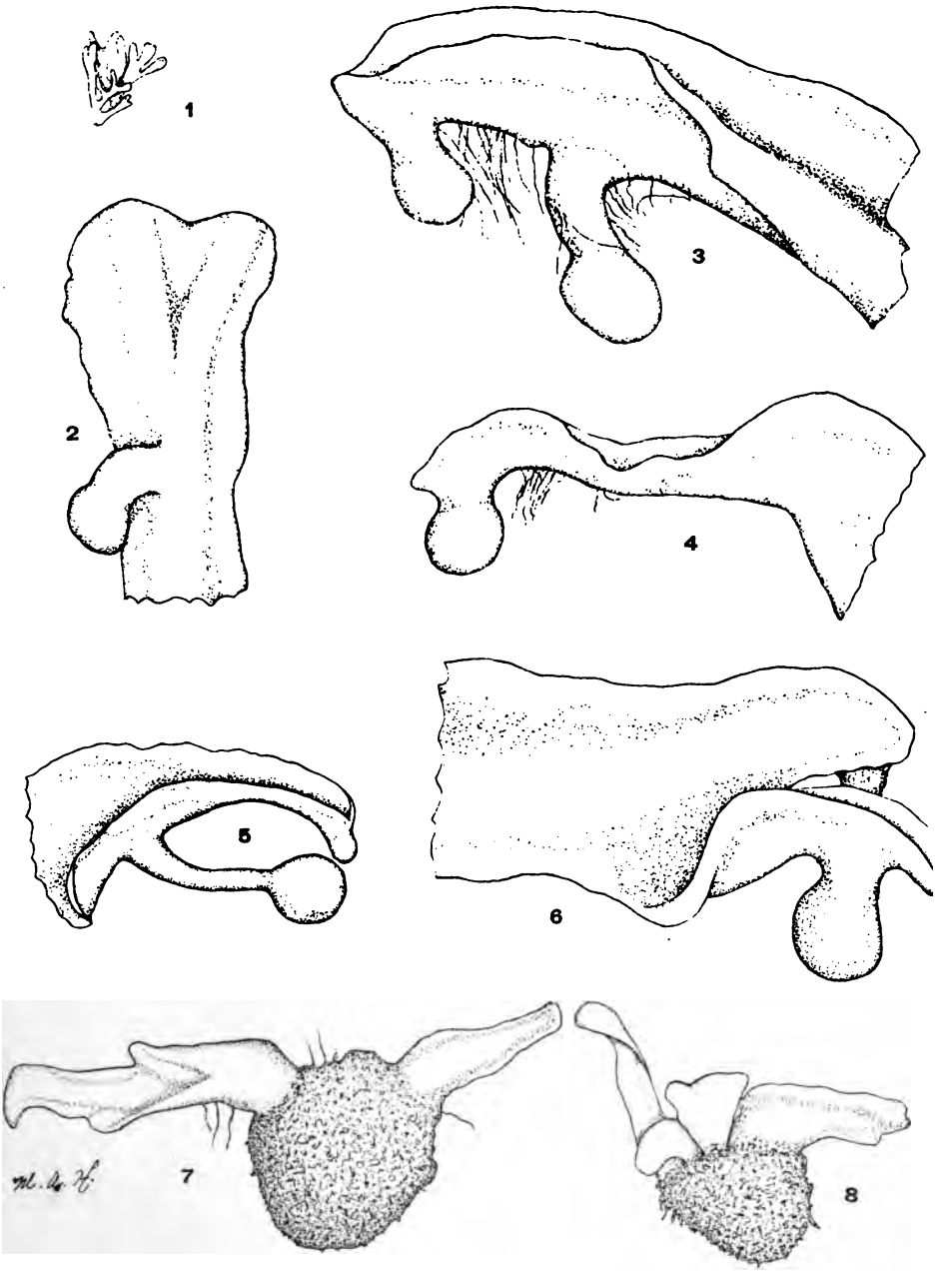

ANTHOCEROS PHYMATODES M. A. Howe.

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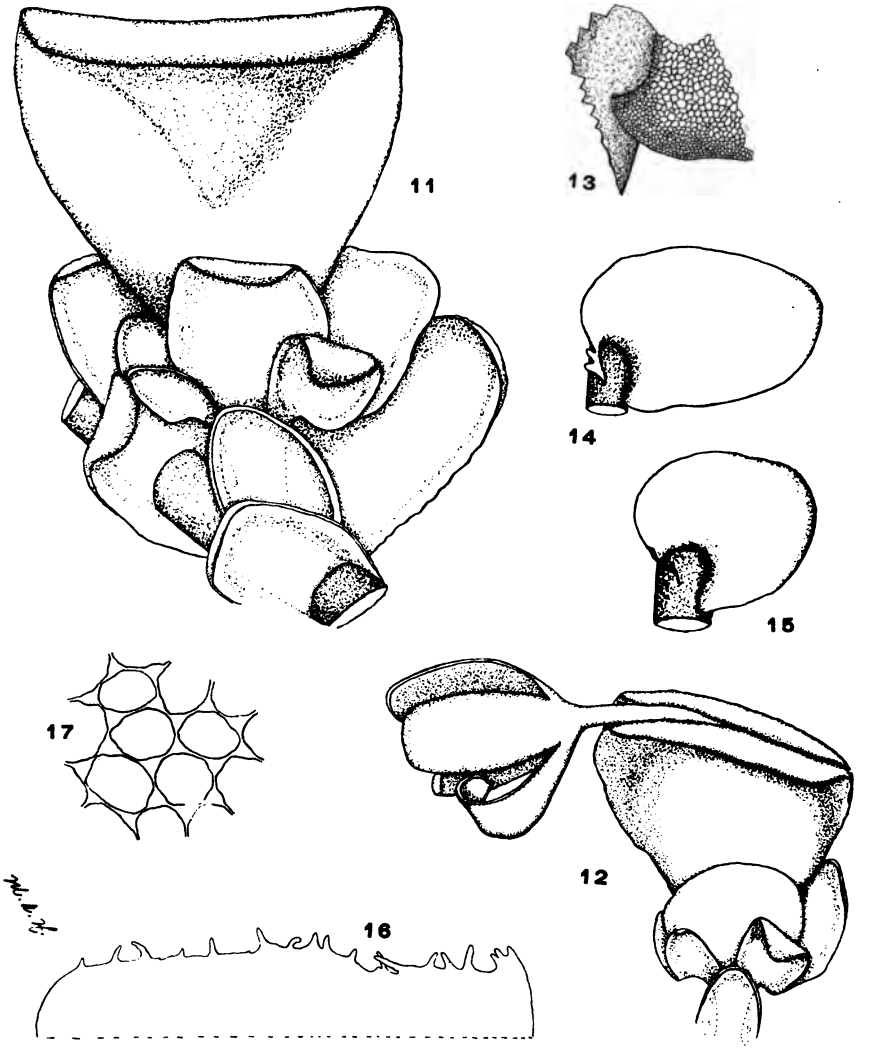

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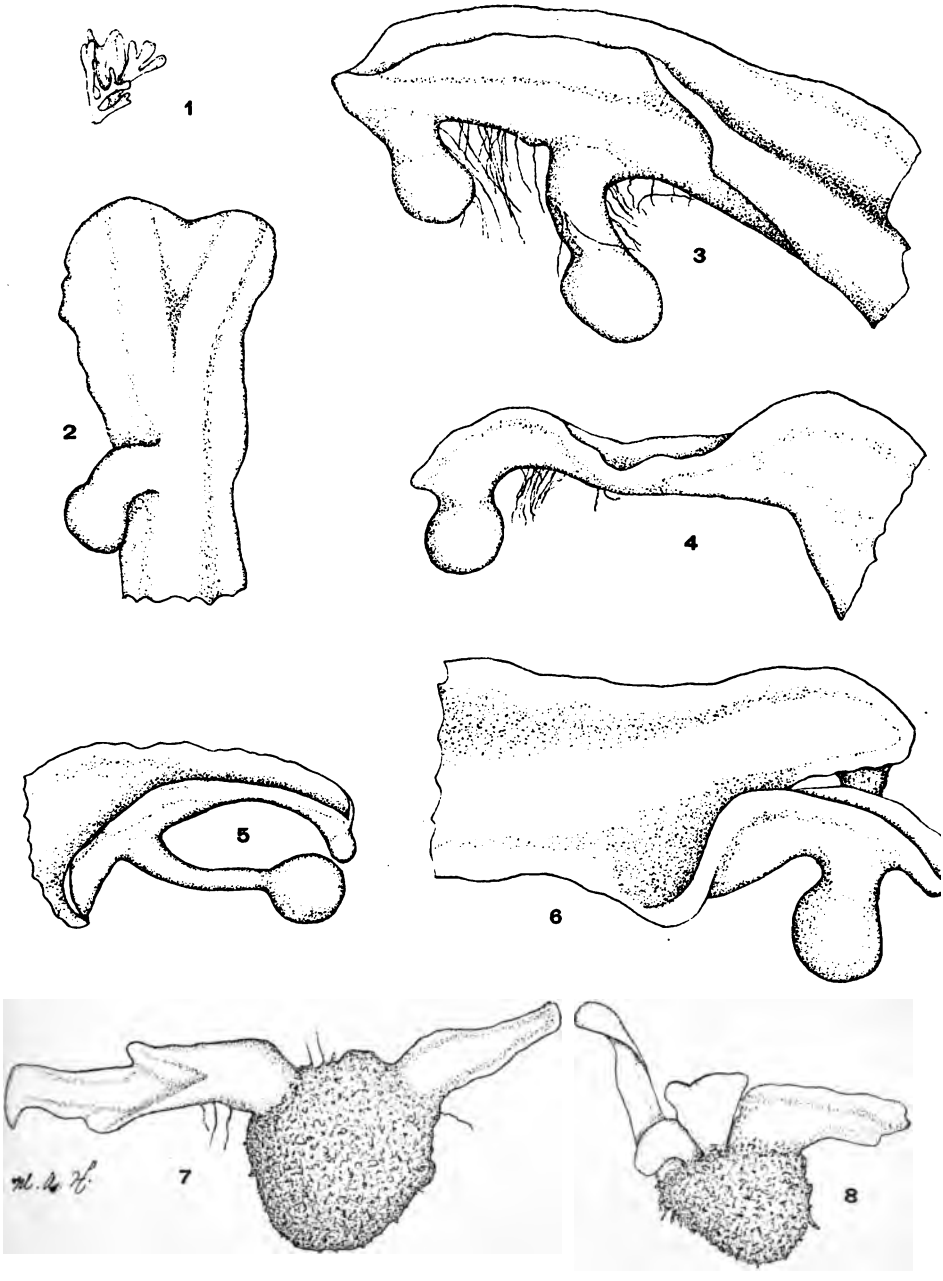

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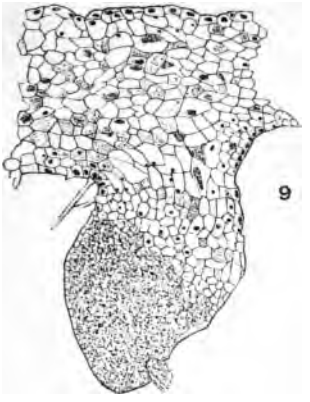

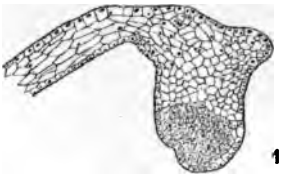

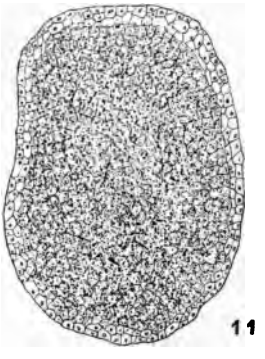

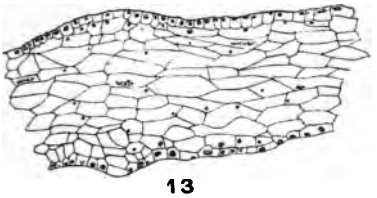

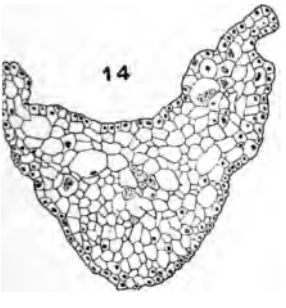

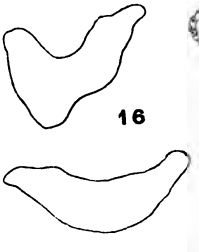

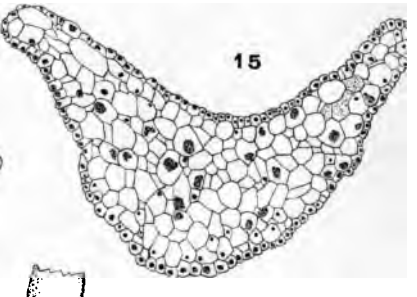

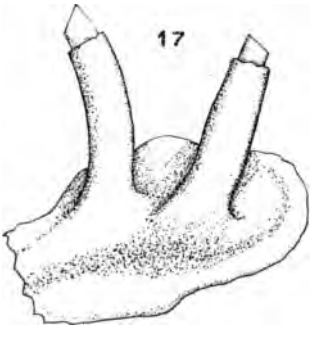

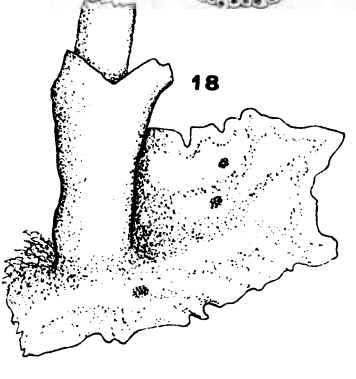

9-17. ANTHOCEROS PHYMATODES M. A. Howe.
18. ANTHOCEROS POLYMORPHUS Raddi, γ DICHOTOMUS Raddi.

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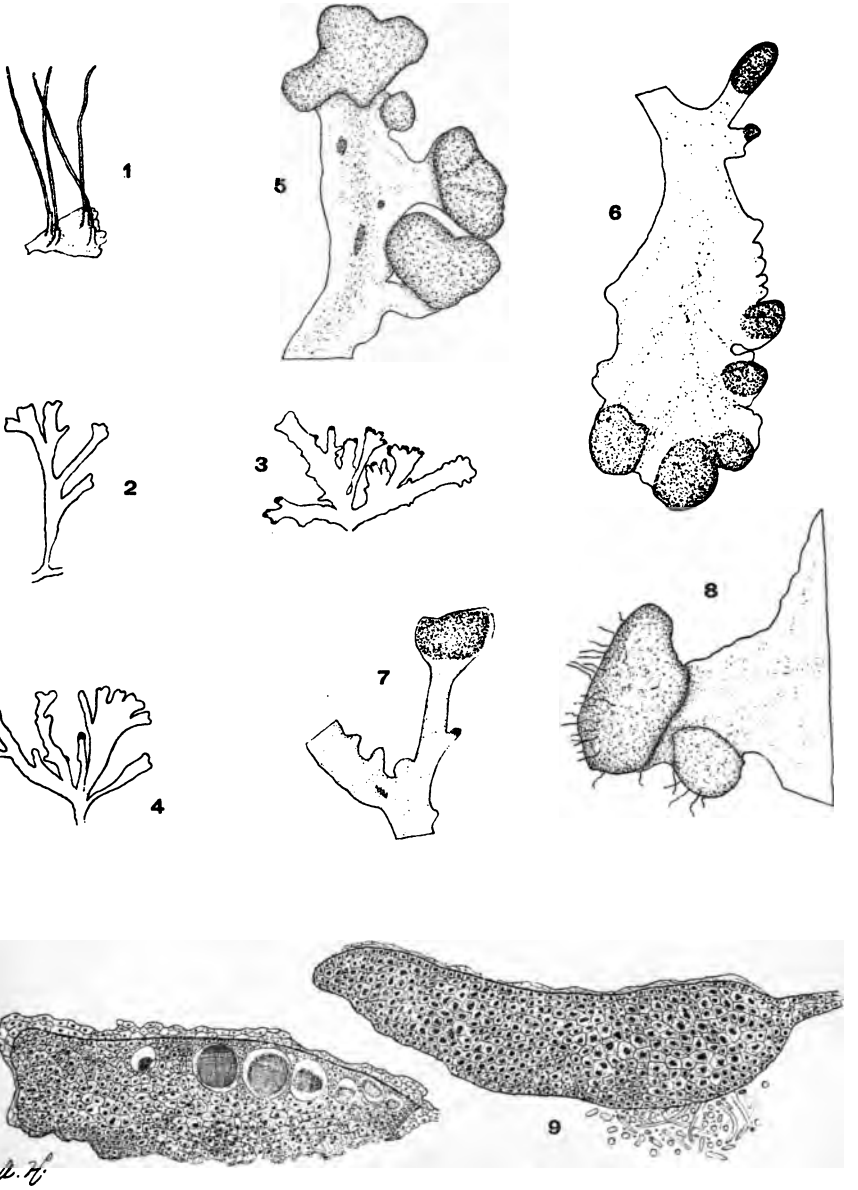
. TORR. BOT. CLUB.



ANTHOCEROS PEARSONI M. A. Howe.

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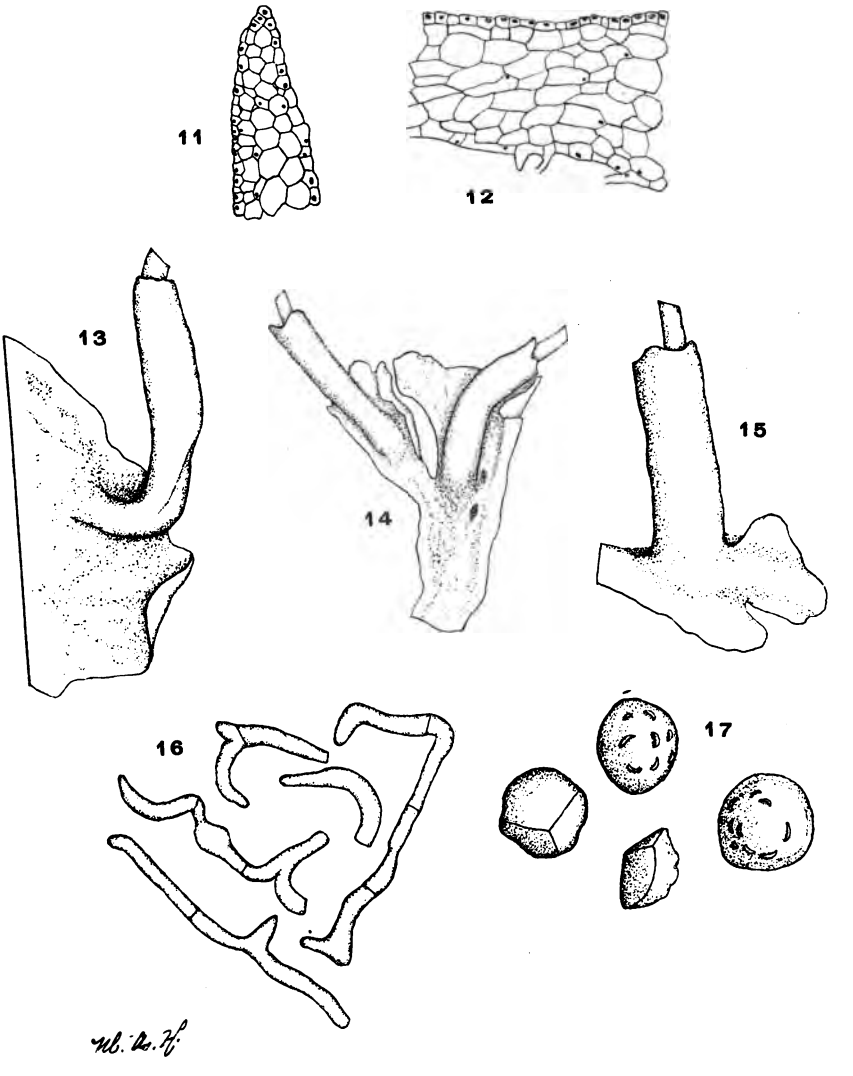

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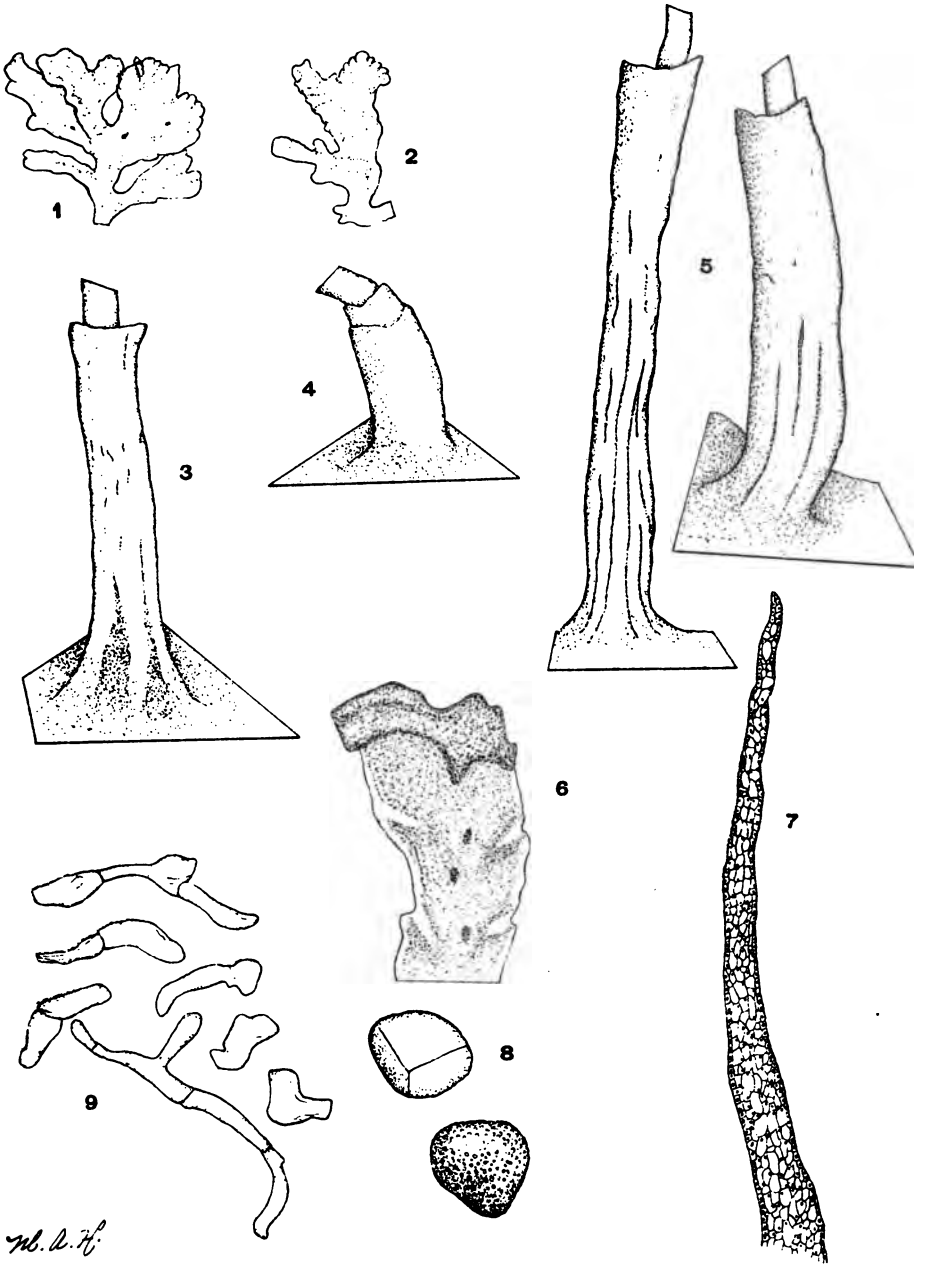

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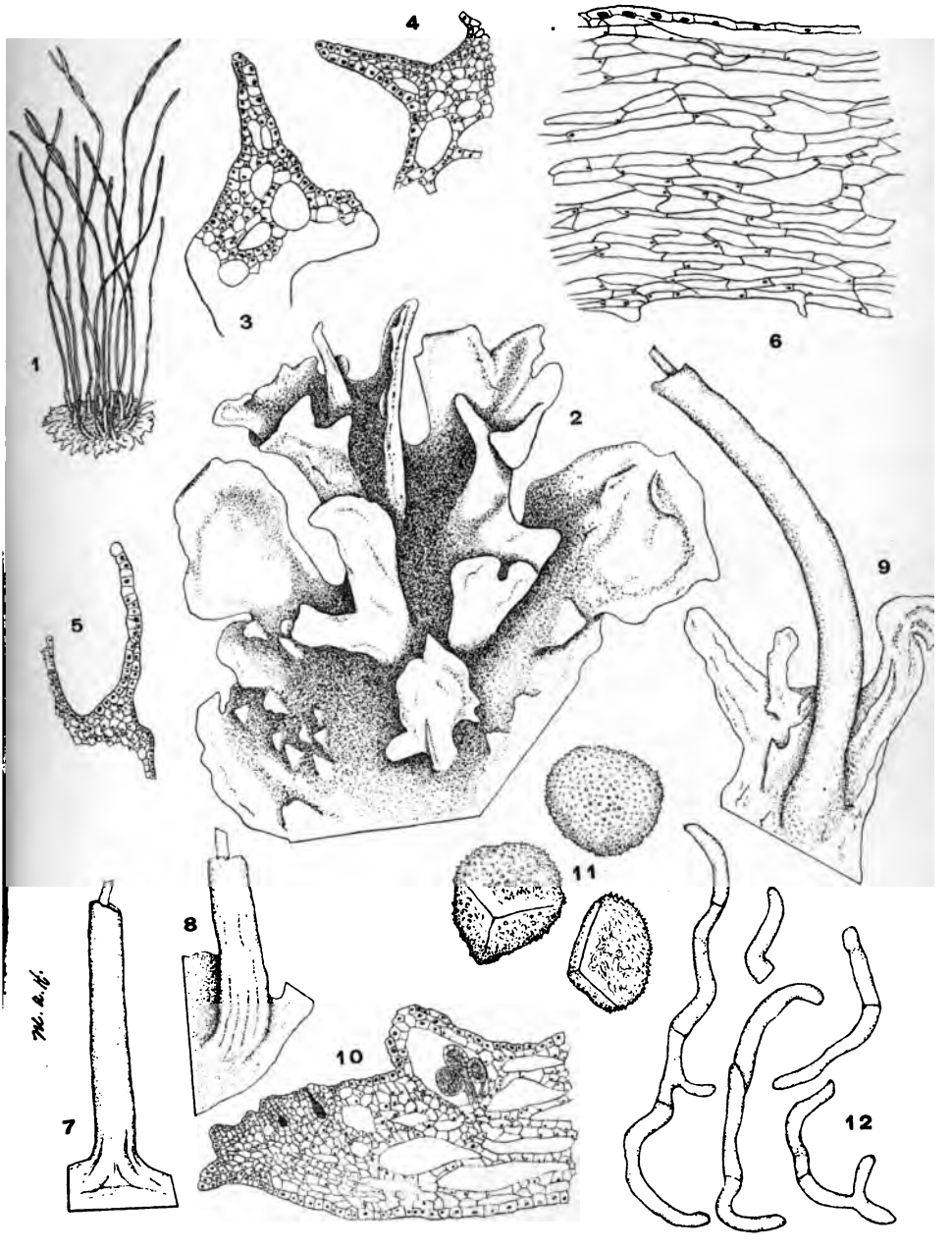

ANTHOCEROS FUSIFORMIS Aust.

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